Appendix E

Selected References Defining the Extent of Groundwater Contamination at the INEEL

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Appendix F

Field Sampling Plan for Operable Unit 10-04
Explosive Compounds

Please refer to the most recent version of the controlled copy of this document.

Field Sampling Plan for Operable Unit 10-04 Explosive Compounds

DOE/ID-10624

Appendix G

Field Sampling Plan for Operable Unit 10-04
Organic-Moderated Reactor Experiment
Soil and Ground Water
(Draft)

Please refer to the most recent version of the controlled copy of this document.

Field Sampling Plan for Operable Unit 10-04 Organic-Moderated Reactor Experiment Soil and Groundwater

DOE/ID-10621

Appendix H

Health and Safety Plans for Operable Unit 10-04

Please refer to the most recent version of the controlled copy of this document.

Health and Safety Plans for Operable Unit 10-04

INEEL/EXT-99-00166

Appendix I

WAG 6 and WAG 10 Lithologic Information

Appendix I

WAG 6 and WAG 10 Lithologic Information

This appendix contains lithologic and geophysical logs for wells in WAGs 6 and 10. Lithologic and geophysical well logs are used to identify and correlate subsurface formations. Their interpretation leads to the development of a conceptual understanding of the ground water pathway, which is described in the WAGs 6 and 10 work plan. Table I-1 identifies the wells presented herein and the type of logs included.

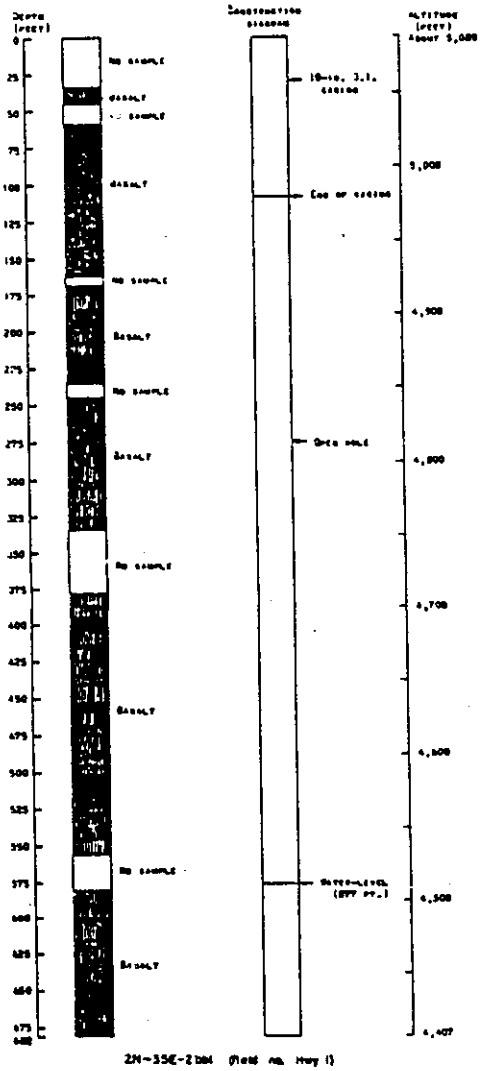
Table I-1. WAGs 6 and 10 well logs.

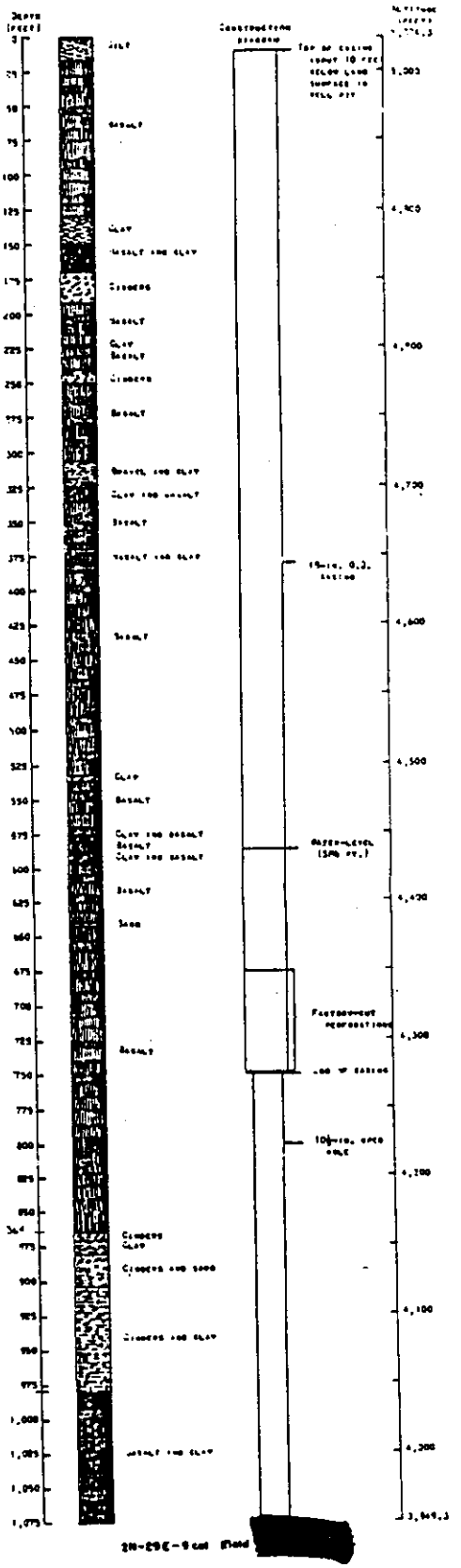
Log	Lithologic	Natural Gamma	Gamma-Gamma	Caliper	Neutron
Well					
EBR-1	X	X	X	X	X
STF-MON-A02A	X	X	X	X	X
EOCR Production	X	X		X	
OMRE	X				
EOCR Injection	X	X		X	
STF-MON-A01A	X	X	X	X	X
Badging Facility	X	X	X	X	X

Well EBR-1

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PLATE 17

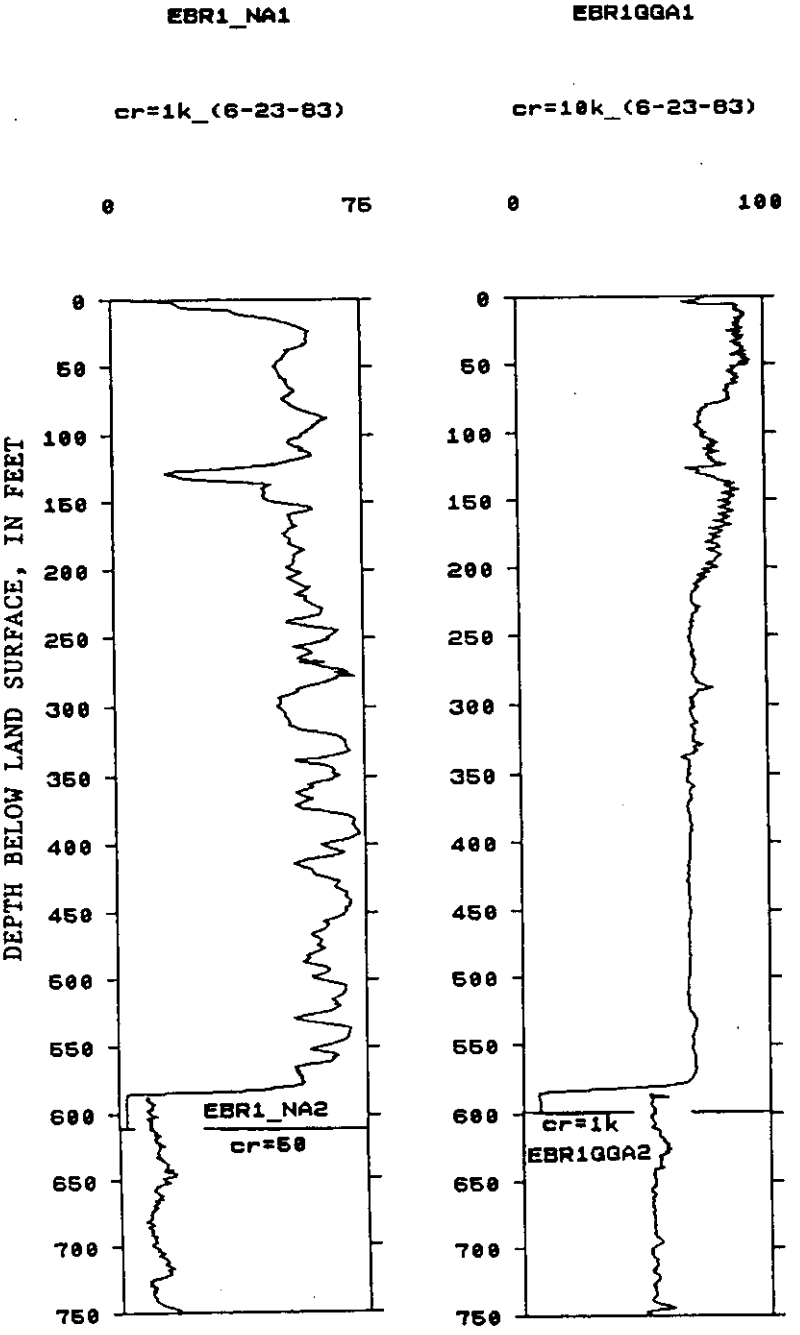




GENERALIZED GRAPHIC LOG OF A TEST HOLE AND A WELL

Well identifier:	EBR-I	Altitude:	5024 ft
Well location:	02N-29E-09caa1	Depth of well:	1075 ft
Latitude and longitude:	433051 1125308	Depth of hole:	1075 ft
Site identifier:	433051113002601	Total depth logged:	1036 ft
County:	Butte		

Remarks: Additional digitized logs are available (see Table 1). Digitized and unprocessed logs are on disk 8. Digitized and processed logs are on disk 10. Neutron log shown was digitized at 2 different scales--cr=1k,50. Gamma-gamma log shown was digitized at 2 different scales--cr=10k,1k. Line breaks indicate base of upper logged intervals. Digitized logs continued on the next 2 pages.



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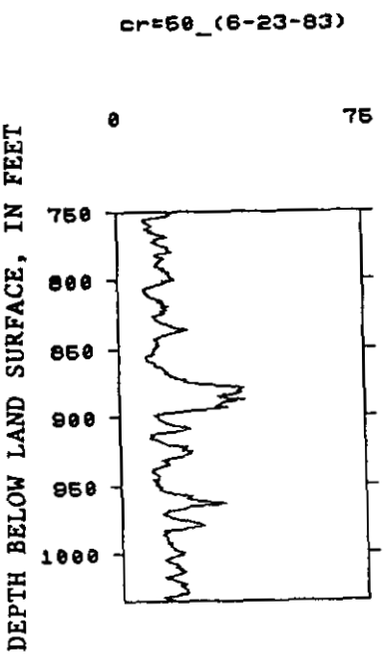
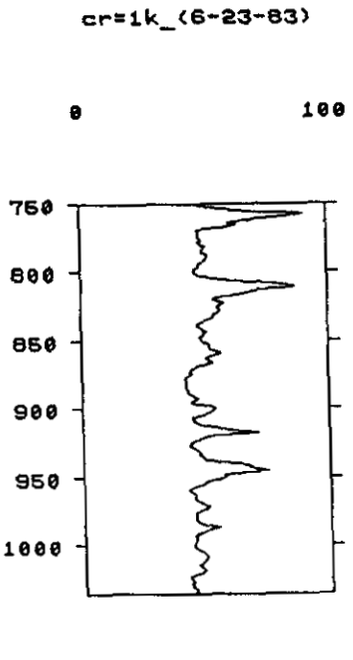
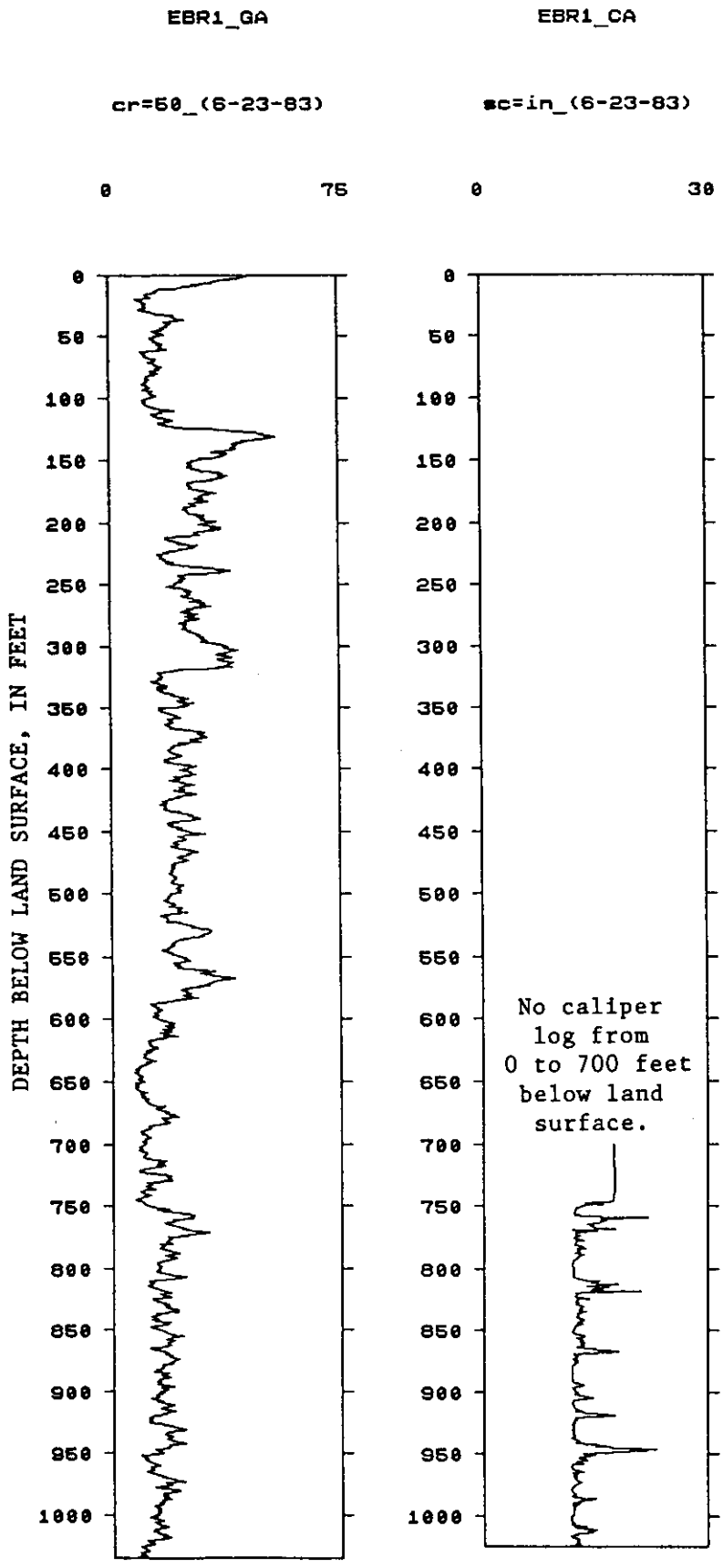


EBR1GGA2--Continued




EBR1_GA
cr=60_(6-23-83)
0
75
EBR1_CA
sc=in_(6-23-83)
0
30
DEPTH BELOW LAND SURFACE, IN FEET
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
No caliper log from 0 to 700 feet below land surface.

Well STF-MON-A02A

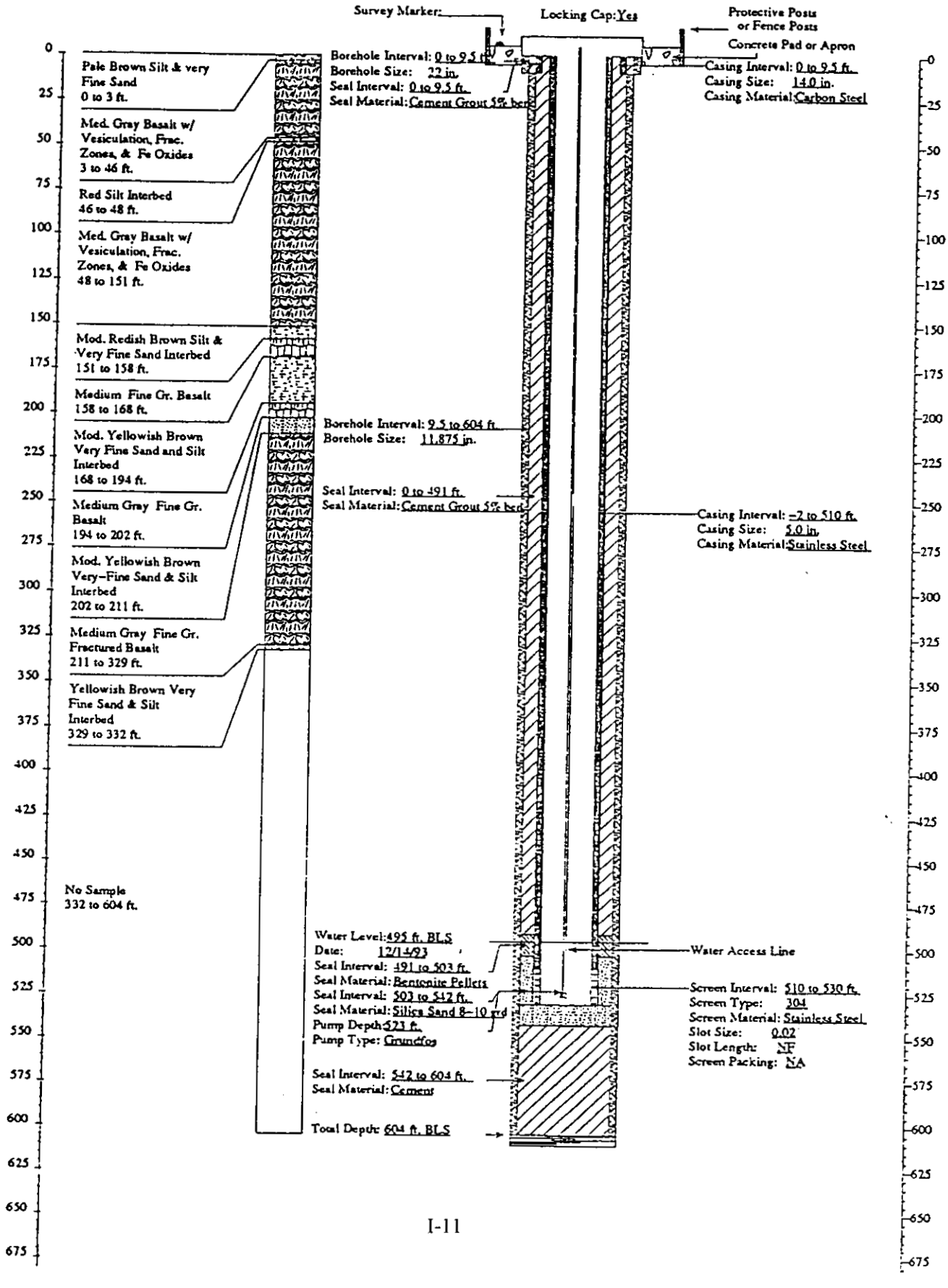
WellName: STF-MON-AQ-02A

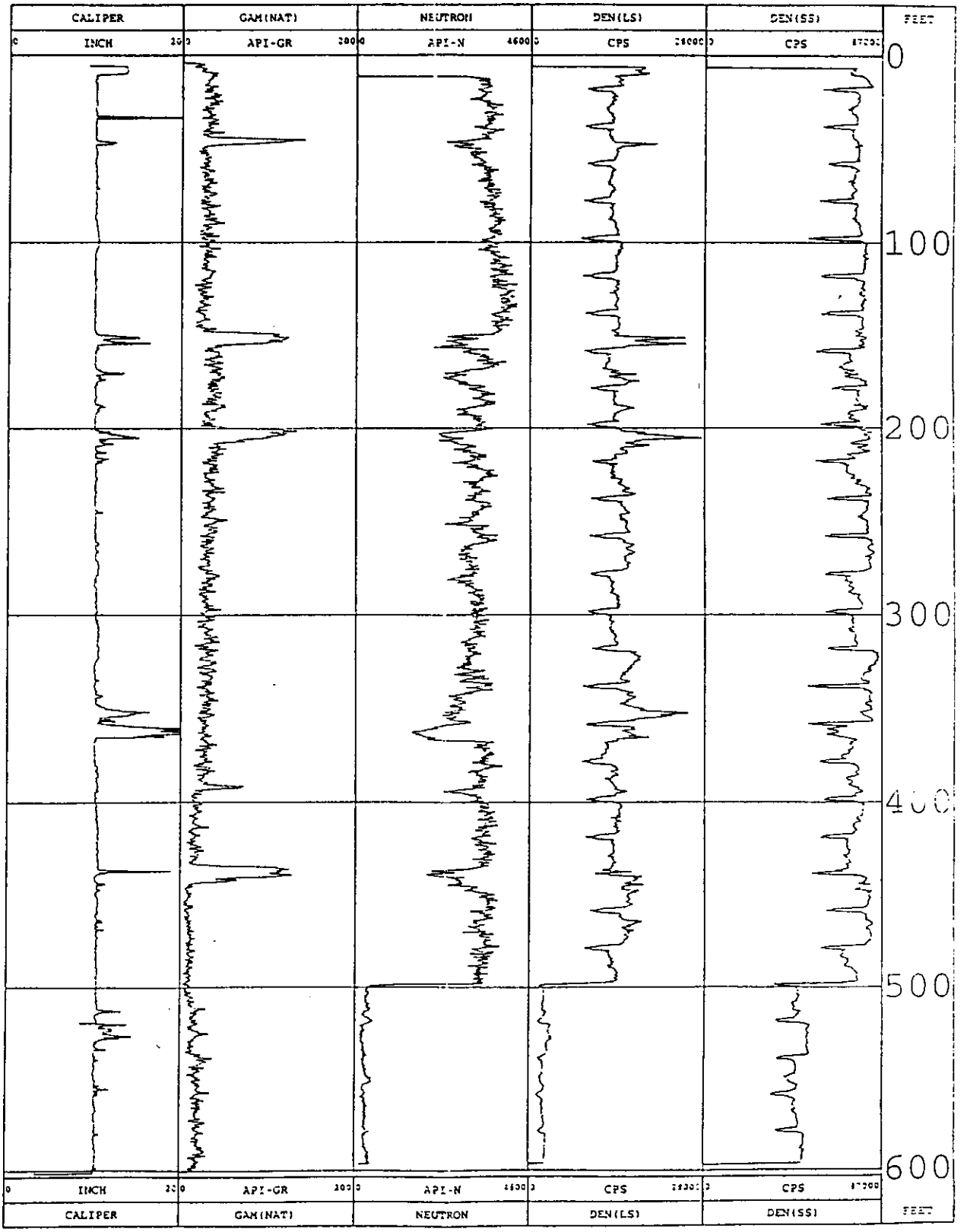
Facility: STF
Well Type: Monitoring
Well Status: Active
Year Drilled: 1994
Total Depth: 604

Easting: 463519.283
Northing: 677831.174
Longitude: 1125334.89838
Latitude: 433127.57504
Completion Depth: 530

Driller: P.C. Exploration
Geologist: T. E. Woosley
Drilling Method: Dual wall reverse hammer
Drilling Fluid: Alcomer
Land Surface: 4940.9

03/07/1994
Water Level: 495
Water Level Date: 12/14/93
Water Level Access: Line




CALIPER
INCH
GAM(NAT)
API-GR
NEUTRON
API-N
DEN(LS)
CPS
DEN(SS)
CPS
FEET
0
100
200
300
400
500
600

EOCR Production Well

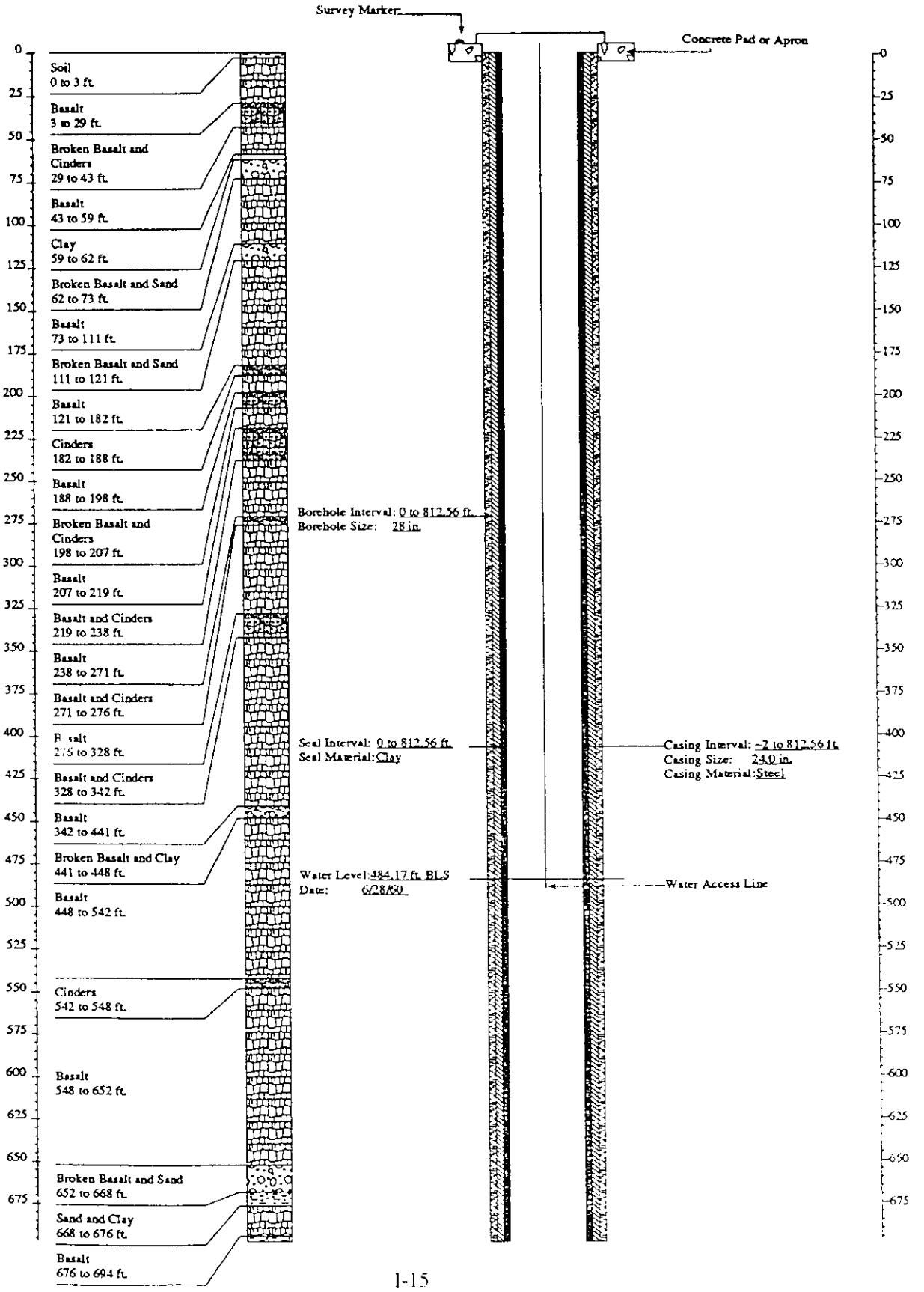
WellName: EOCR PRODUCTION WELL Corrections:WELL IS LOCATED IN A WELL HOUSE 03/08/1994

Facility: SOUTH
Well Type: Potable Water
Well Status: Inactive
Year Drilled: 1960
Total Depth: 1237

Easting: 462098.99
Northing: 677057.45
Longitude: 1125354.0827
Latitude: 433119.81078
Completion Depth: 1237

Driller: Strasser
Geologist: NF
Drilling Method: Cable tooled
Drilling Fluid: NF
Land Surface: 4943.31

Water Level: 484.17
Water Level Date: 6/28/60
Water Level Access: Line



WellName: EOCR PRODUCTION WELL Corrections: WELL IS LOCATED IN A WELL HOUSE

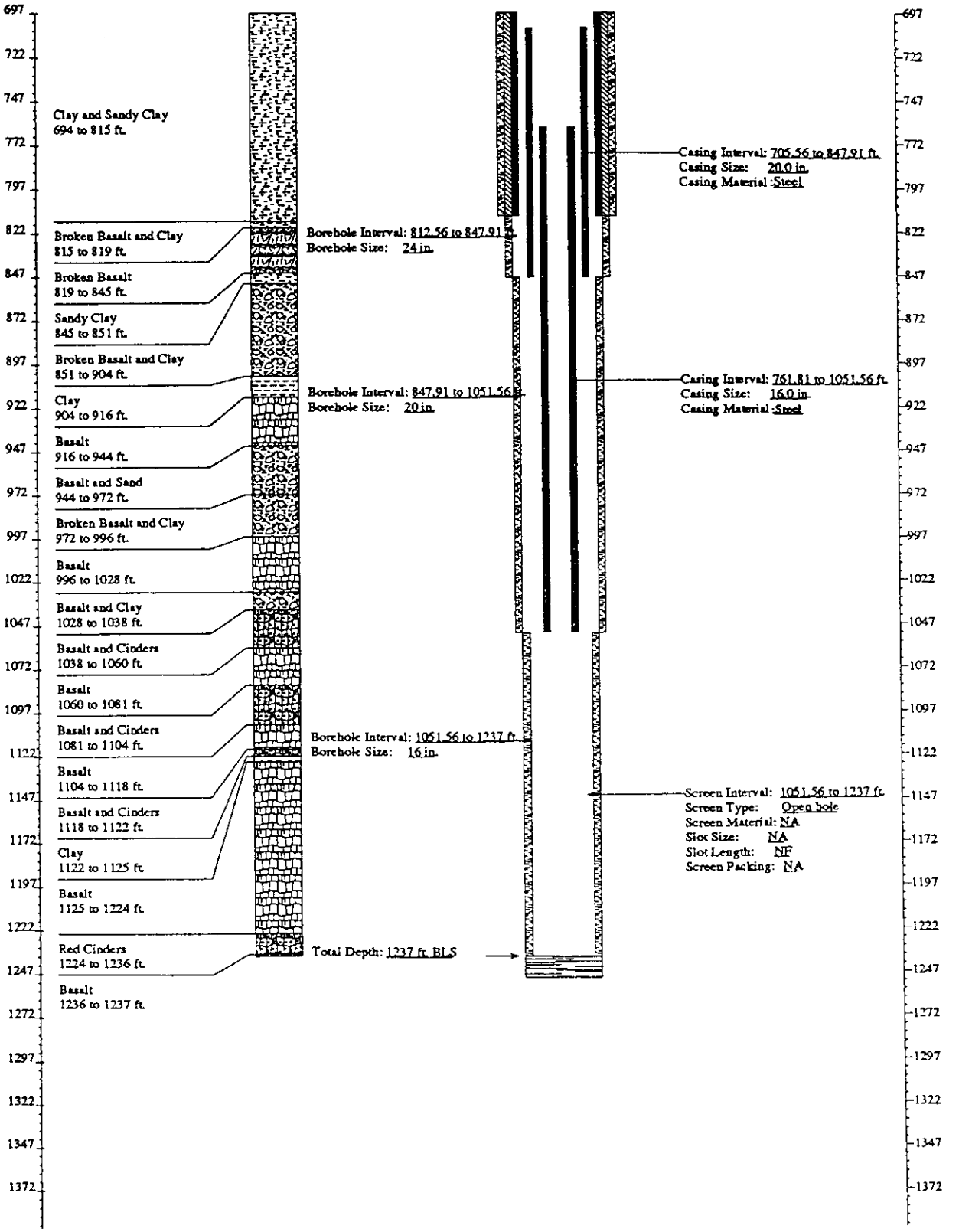
03/08/1994

Facility: SOUTH
Well Type: Potable Water
Well Status: Inactive
Year Drilled: 1960
Total Depth: 1237

Easting: 462098.99
Northing: 677057.45
Longitude: 1125354.0827
Latitude: 433119.81078
Completion Depth: 1237

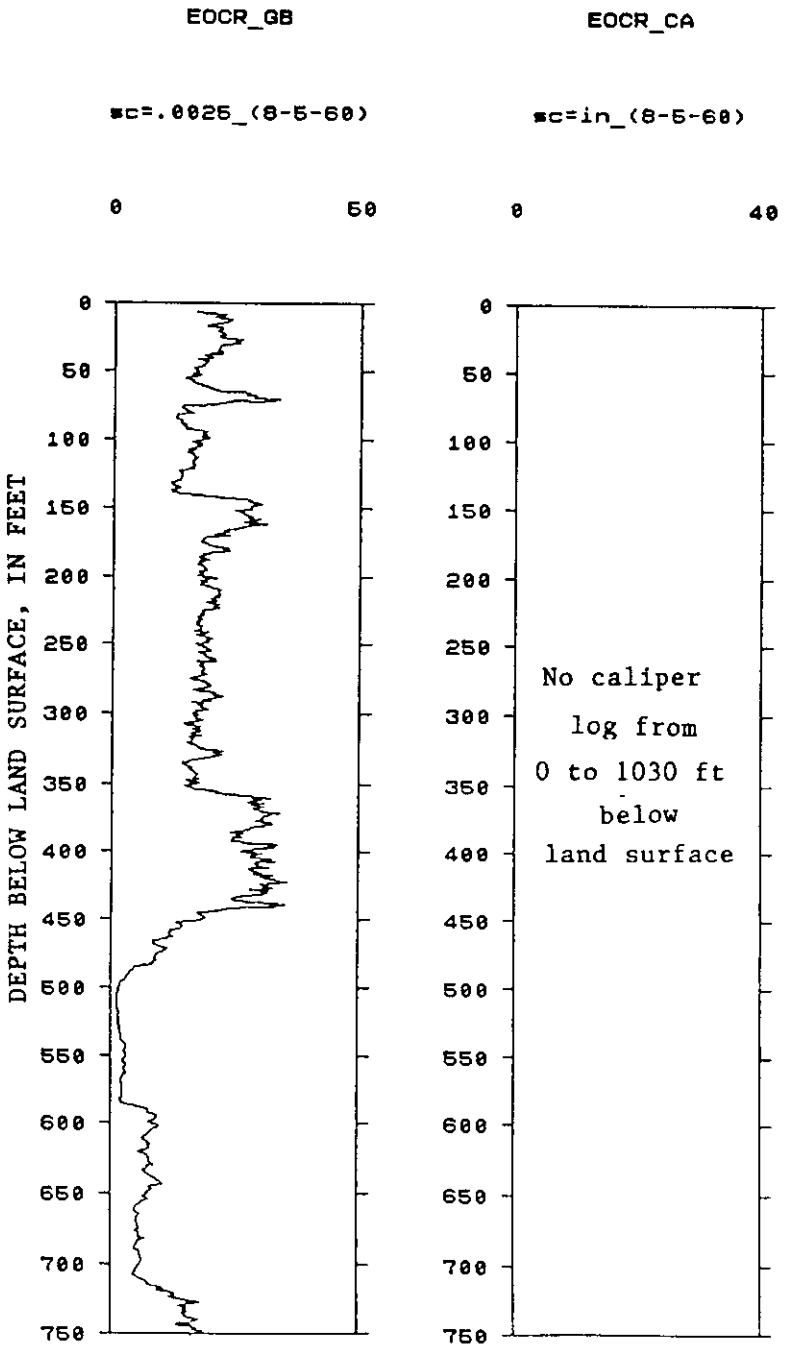
Driller: Strasser
Geologist: NF
Drilling Method: Cable tooled
Drilling Fluid: NF
Land Surface: 4943.31

Water Level: 484.17
Water Level Date: 6/28/60
Water Level Access: Line

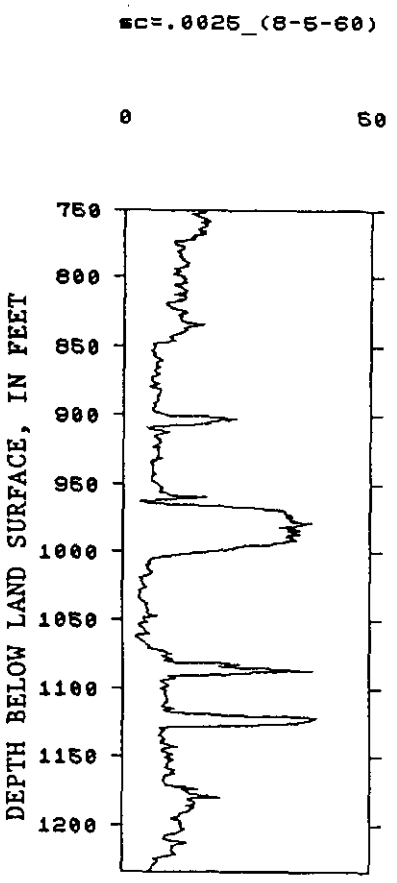


Well identifier:	EOCR	Altitude:	4939 ft
Well location:	02N-30E-05ddd1	Depth of well:	1237 ft
Latitude and longitude:	433120 1125349	Depth of hole:	1237 ft
Site identifier:	433120112535101	Total depth logged:	1237 ft
County:	Butte		

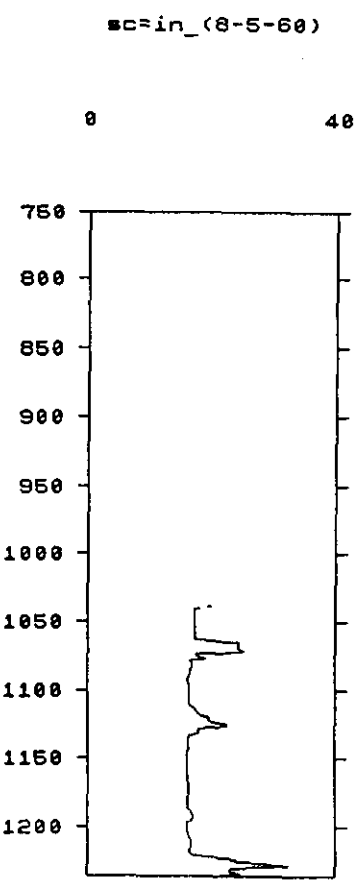
Remarks: Digitized and unprocessed logs are on disk 7. Digitized and processed logs are on disk 8. Digitized logs continued on the next page.



EOCR_GB--Continued



EOCR_CA--Continued



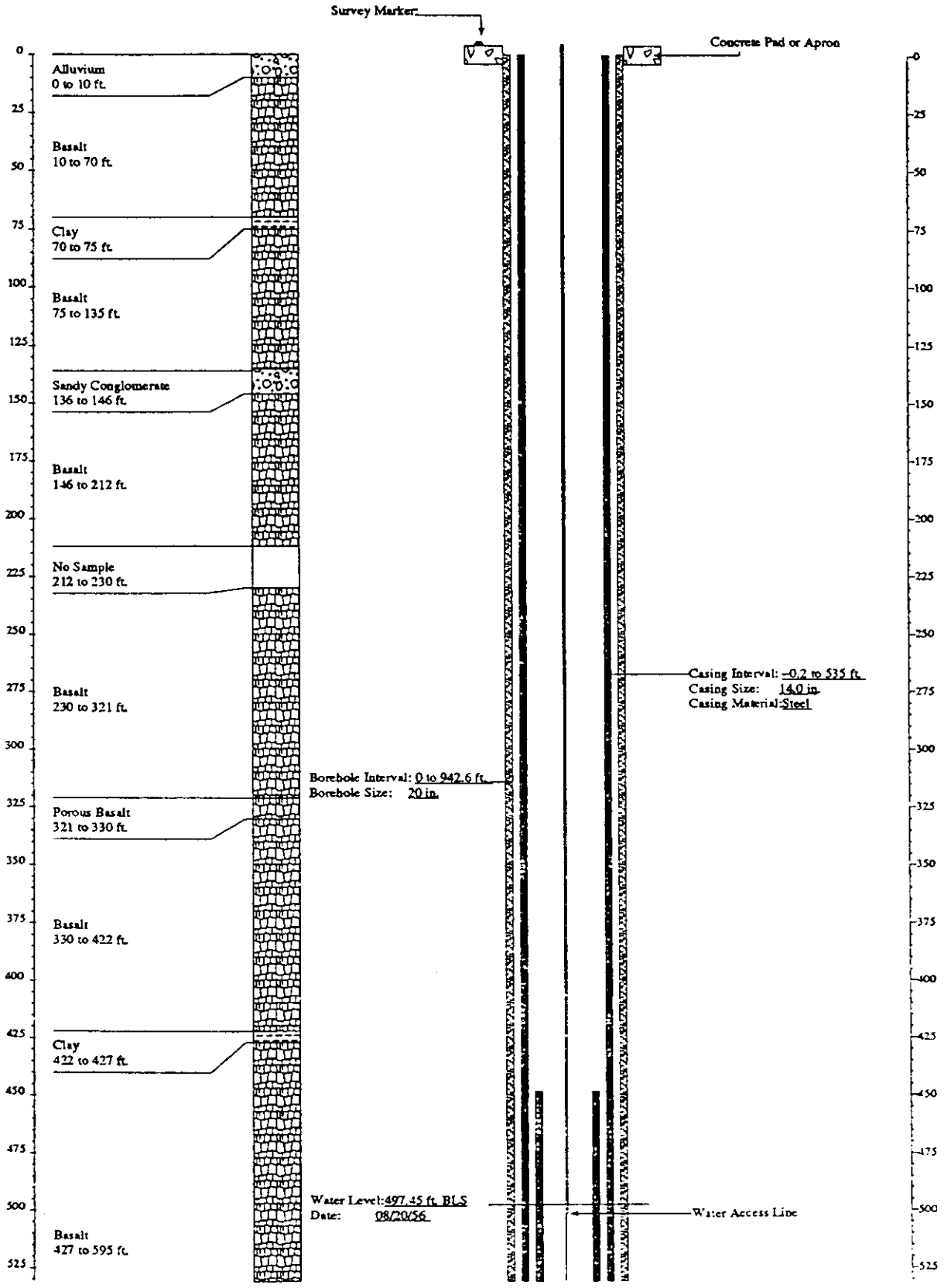
Well OMRE

WellName: OMRE
Facility: SOUTH
Well Type: Potable Water
Well Status: Inactive
Year Drilled: 1957
Total Depth: 942.6

Corrections: WELL IS LOCATED IN A WELL HOUSE
Easting: 462451.13
Northing: 676705.74
Longitude: 1125349.2614
Latitude: 433116.34814
Completion Depth: 942.6

Driller: Strasser
Geologist: Alan E. Peckham
Drilling Method: Cable tooled
Drilling Fluid: NF
Land Surface: 4939.83

06/23/1994
Water Level: 497.45
Water Level Date: 08/20/56
Water Level Access: Line



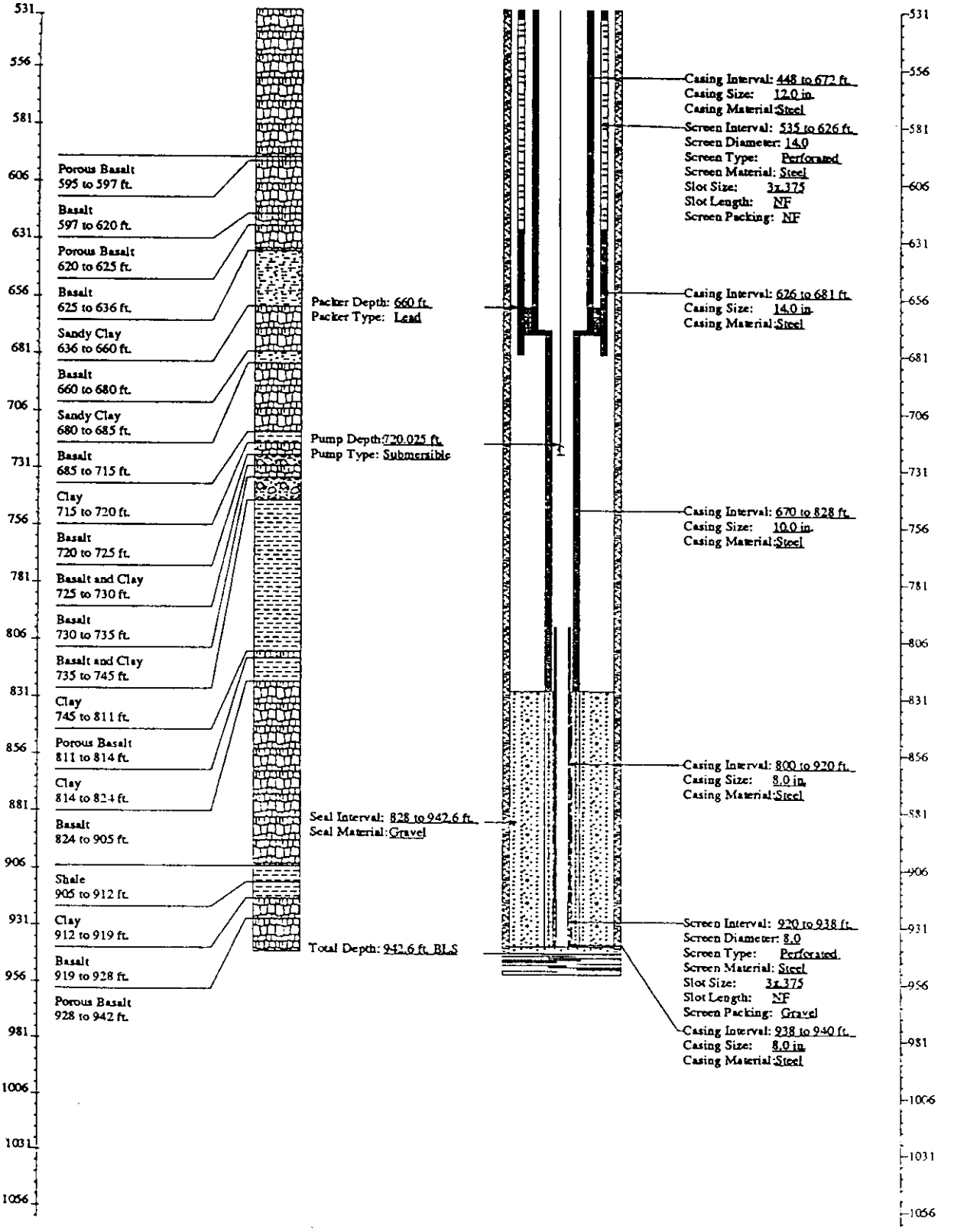
WellName: OMRE
Facility: SOUTH
Well Type: Potable Water
Well Status: Inactive
Year Drilled: 1957
Total Depth: 942.6

Corrections: WELL IS LOCATED IN A WELL HOUSE

Easting: 462451.13
Northing: 676703.74
Longitude: 1125349.2614
Latitude: 433116.34814
Completion Depth: 942.6

Driller: Strasser
Geologist: Alan E. Peckham
Drilling Method: Cable tooled
Drilling Fluid: NF
Land Surface: 4939.83

06/23/1994
Water Level: 497.45
Water Level Date: 06/20/56
Water Level Access: Line



EOCR Injection Well

WellName: EOCR INJECTION WELL

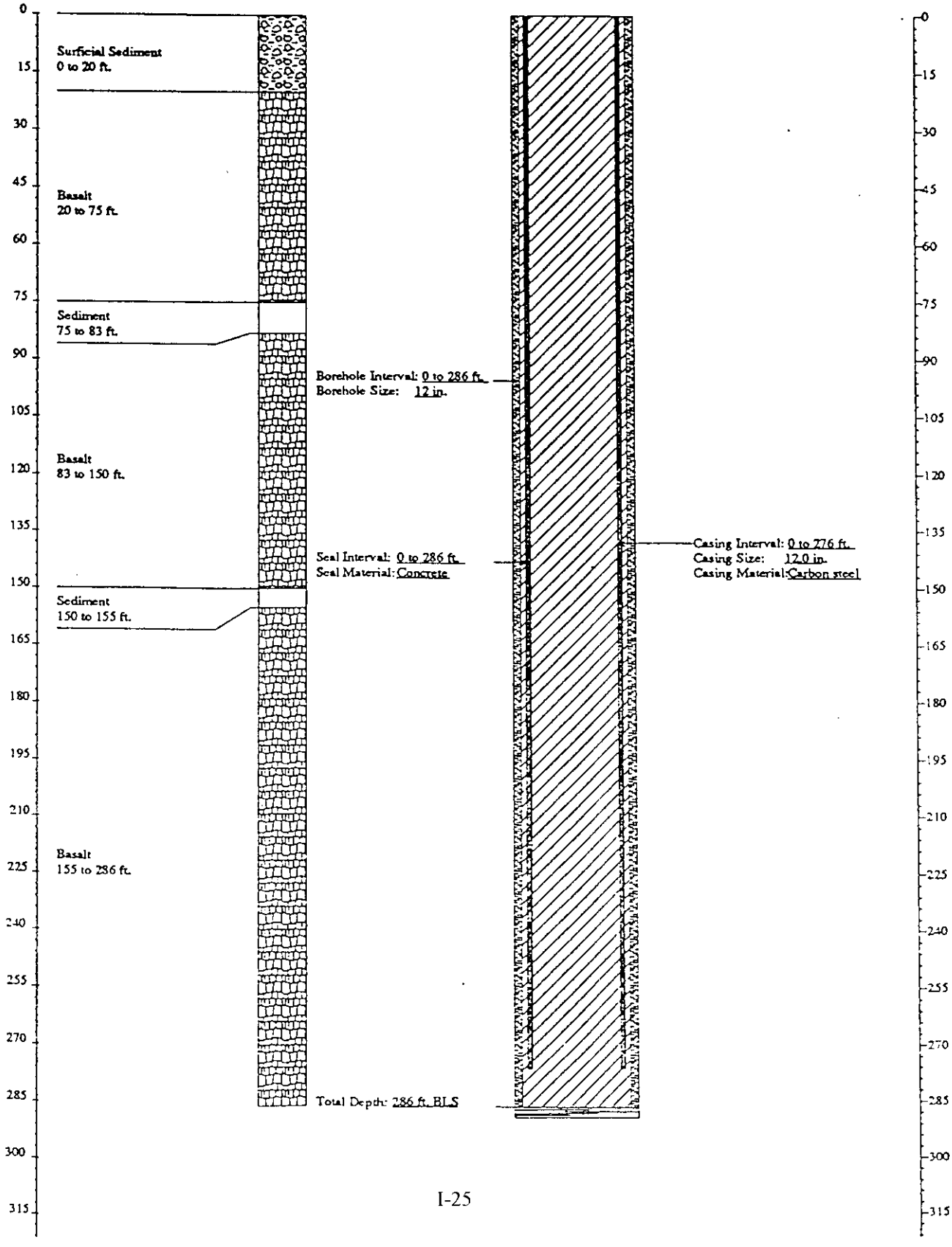
06/14/1993

Facility: SOUTH
Well Type: NA
Well Status: Abandoned
Year Drilled: 1962
Total Depth: 286

Easting: 306373
Northing: 676722
Longitude: 1125347.99
Latitude: 433116.62
Completion Depth: 285

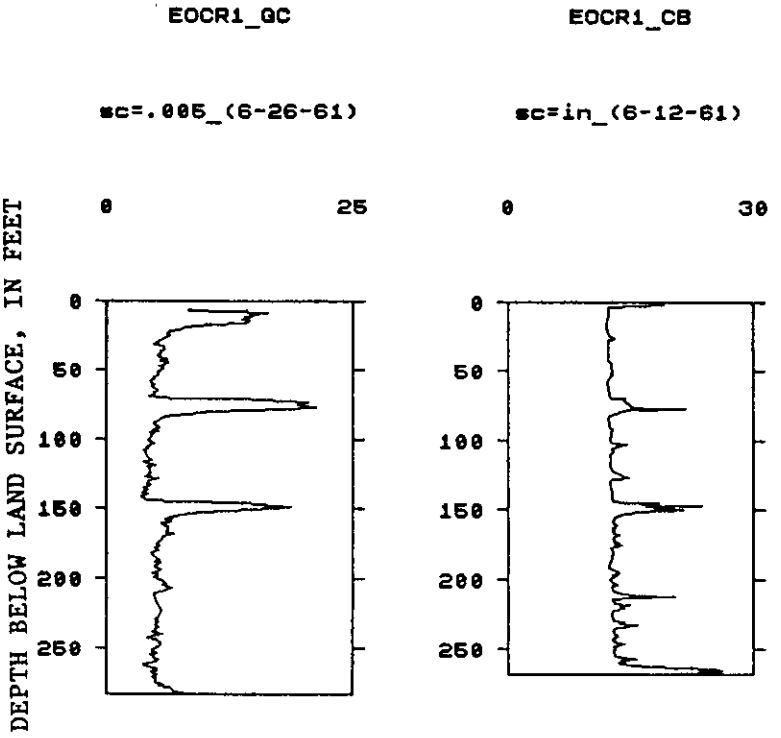
Driller: Andrews
Geologist: E. Shuter
Drilling Method: NF
Drilling Fluid: NF
Land Surface: 4937

Water Level: Dry
Water Level Date: NF
Water Level Access: NF



Well identifier:	EOCR (Disp)	Altitude:	4937 ft
Well location:	02N-30E-05ddd2	Depth of well:	--
Latitude and longitude:	433119 1125346	Depth of hole:	--
Site identifier:	--	Total depth logged:	285 ft
County:	Butte		

Remarks: Additional digitized and undigitized logs are available (see Table 1). Digitized and unprocessed logs are on disk 7. Digitized and processed logs are on disk 8.



Well STF-MON-A01A

WellName: STF-MON-AQ-01A

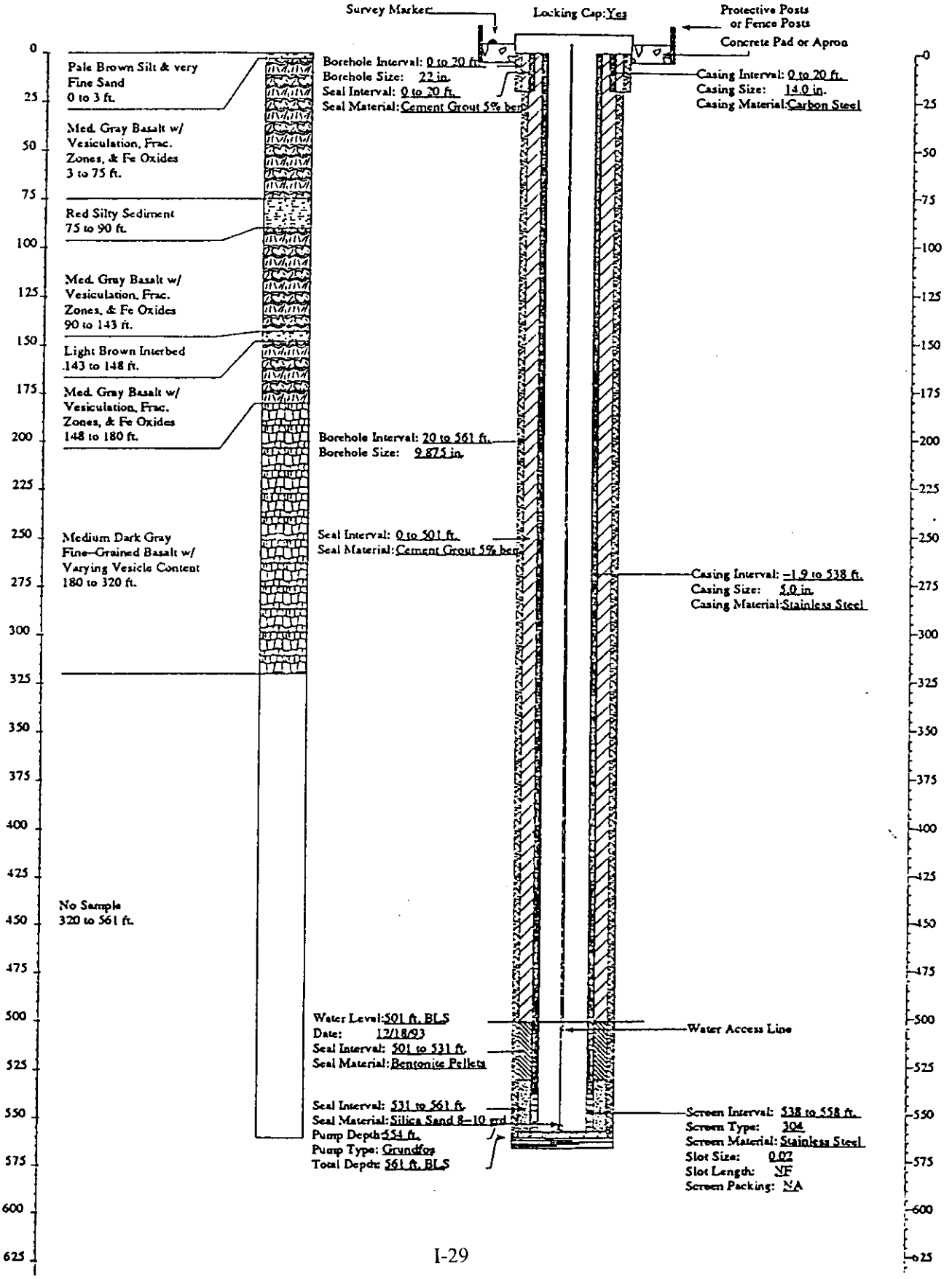
03/07/1994

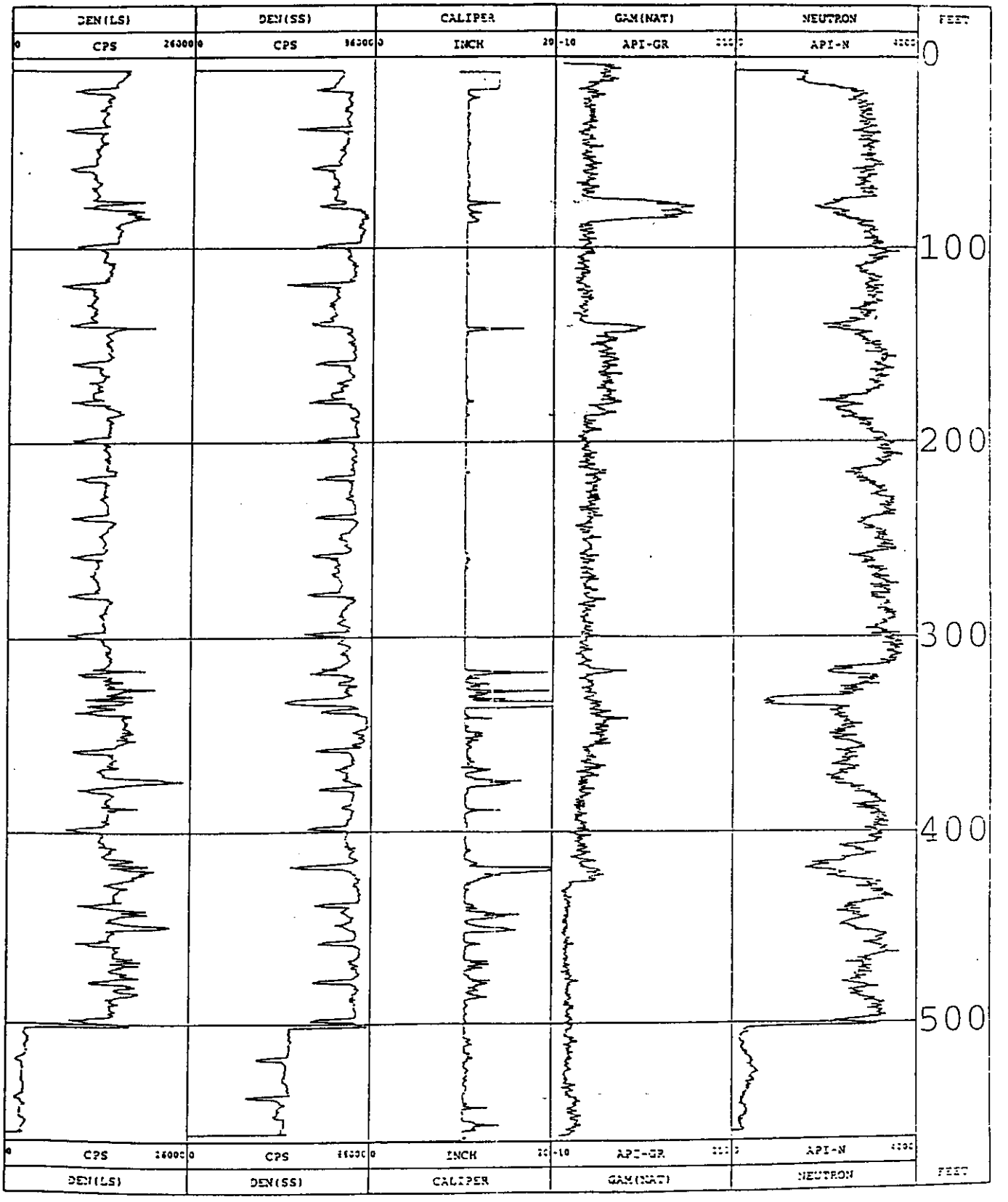
Facility: STF
Well Type: Monitoring
Well Status: Active
Year Drilled: 1994
Total Depth: 561

Easting: 462185.985
Northing: 676260.560
Longitude: 1125352.80706
Latitude: 433111.94831
Completion Depth: 558

Driller: P.C. Exploration
Geologist: T. E. Woosley
Drilling Method: Dual wall reverse hammer
Drilling Fluid: Alcomer
Land Surface: 4944.9

Water Level: 501
Water Level Date: 12/18/93
Water Level Access: Line




DEN(LS)
CPS
DEN(SS)
CPS
CALIPER
INCH
GAM(NAT)
API-GR
NEUTRON
API-N
FEET
0
100
200
300
400
500

Badging Facility Well

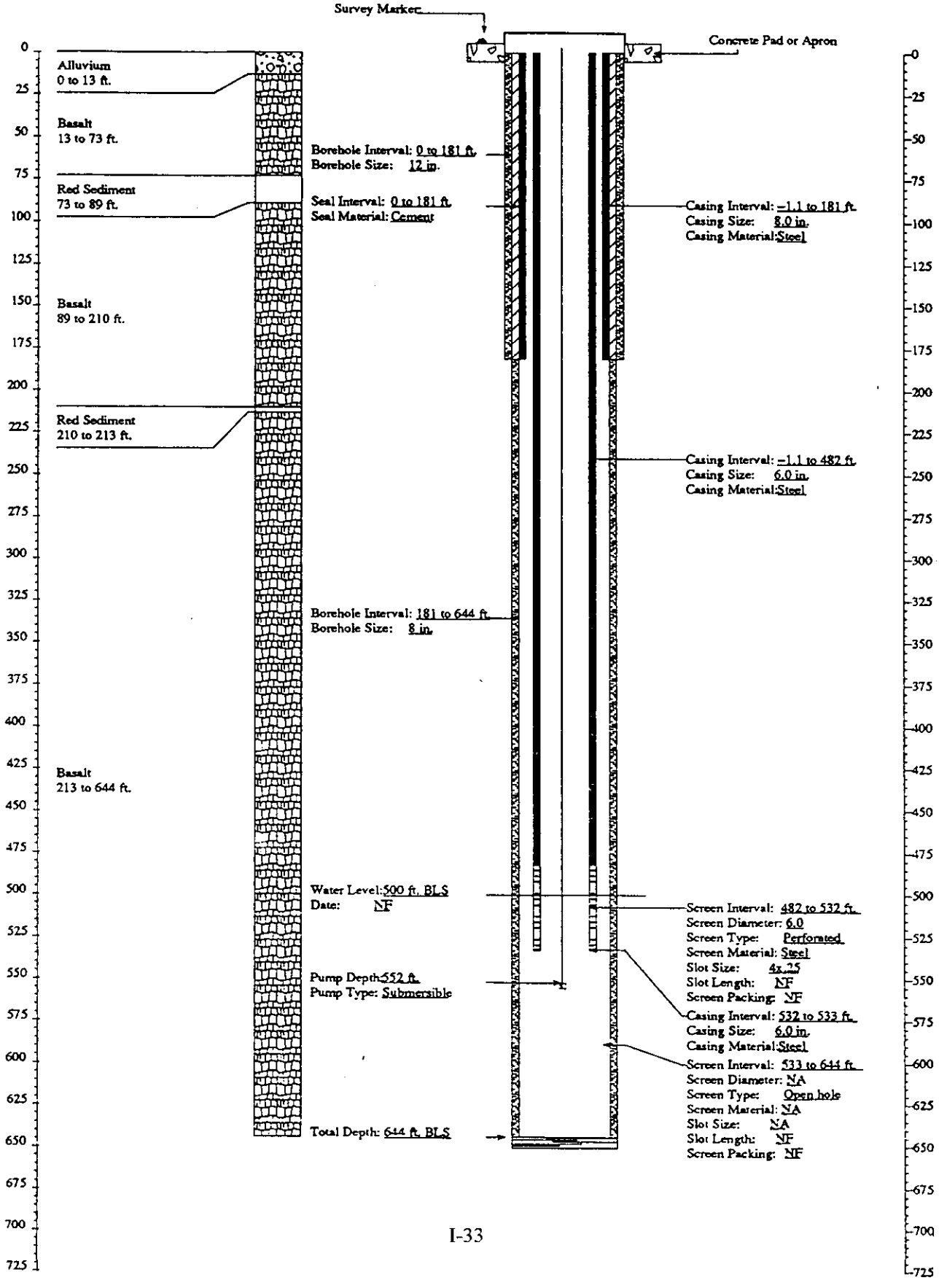
WellName: BADGING FACILITY WELL Corrections:WELL IS LOCATED IN A WELL HOUSE 06/21/1994

Facility: SOUTH
Well Type: Potable Water
Well Status: Active
Year Drilled: 1985
Total Depth: 644

Easting: 462253.86
Northing: 673015.82
Longitude: 1125351.4990
Latitude: 433039.90917
Completion Depth: 644

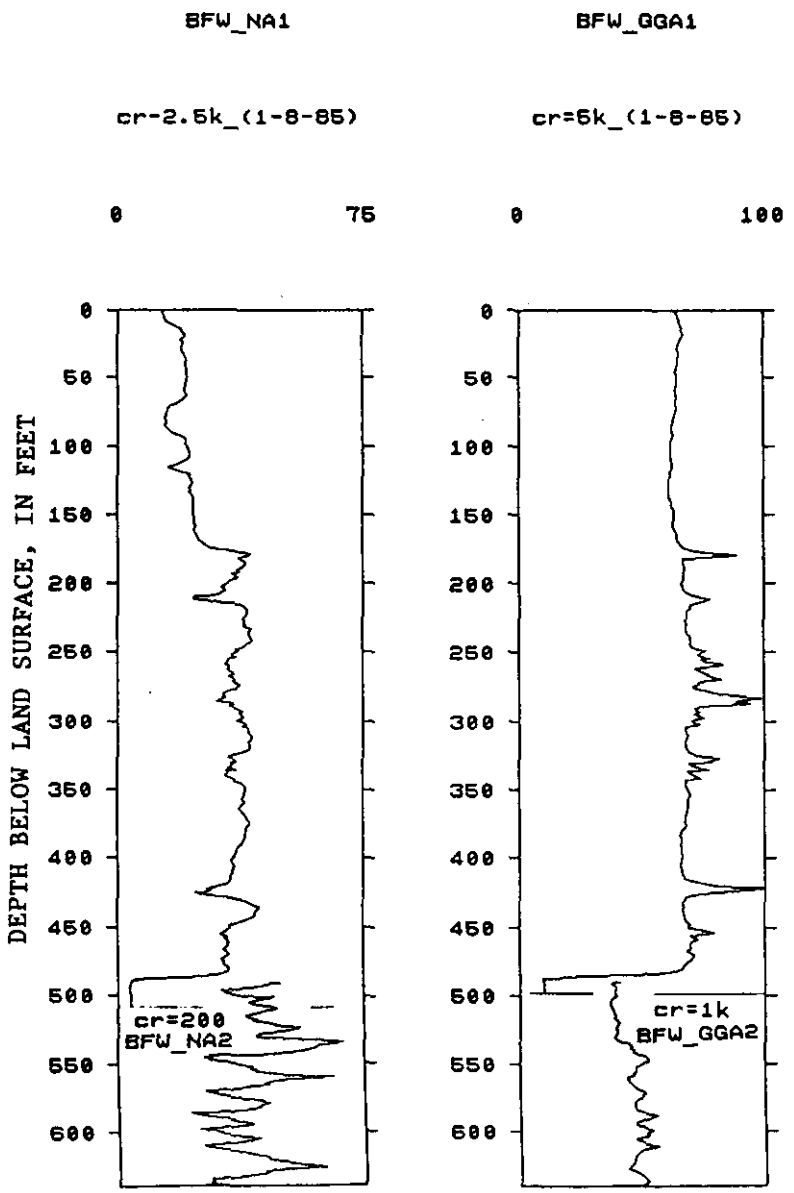
Driller: Denning
Geologist: NF
Drilling Method: Air rotary
Drilling Fluid: NF
Land Surface: 4938.95

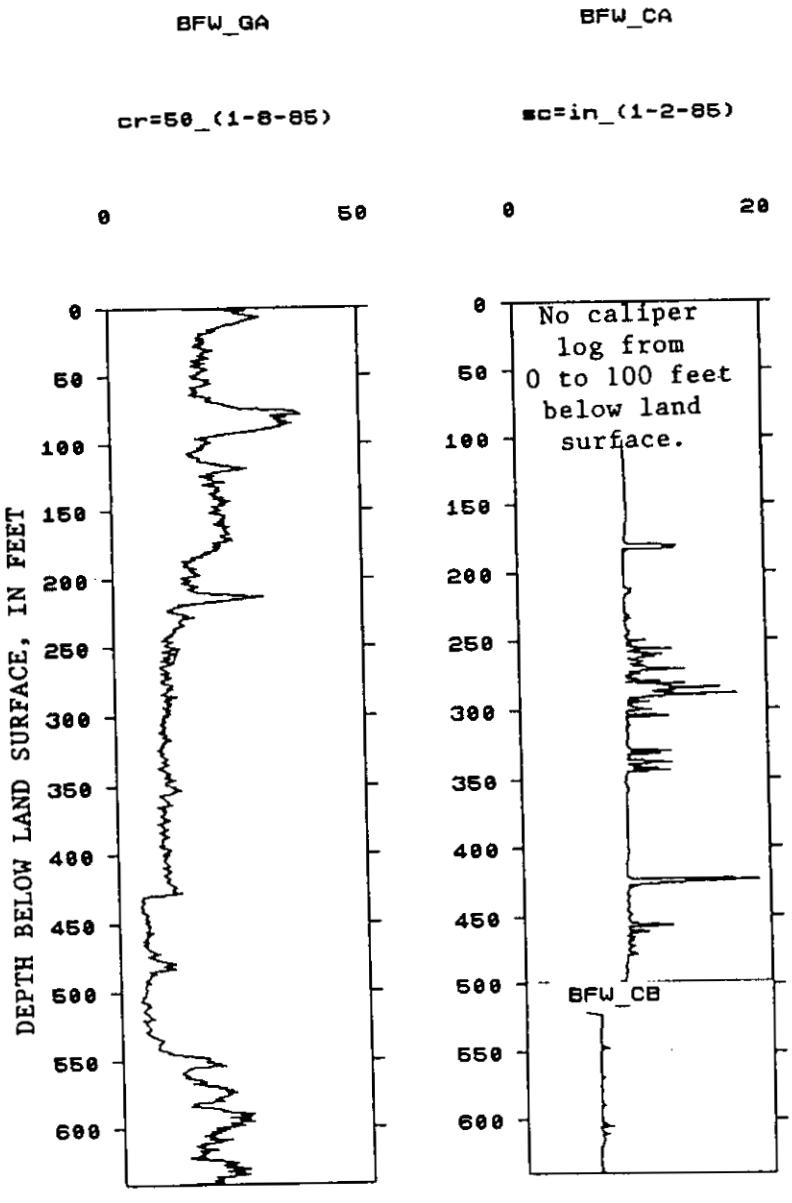
Water Level: 500
Water Level Date: NF
Water Level Access: NF



Well identifier:	Badging Facility Well	Altitude:	4934 ft
Well location:	02N-30E-08dad1	Depth of well:	644 ft
Latitude and longitude:	433042 1125351	Depth of hole:	644 ft
Site identifier:	433042112535101	Total depth logged:	640 ft
County:	Butte		

Remarks: Additional digitized logs are available (see Table 1). Digitized and unprocessed logs are on disk 7. Digitized and processed logs are on disk 8. Neutron log shown was digitized at 2 different scales--cr=2.5k,200. Gamma-gamma log shown was digitized at 2 different scales--cr=5k,1k. Line breaks indicate base of upper logged interval. Caliper log shown is a combination of 2 digitized logs. Line break separates BFW_CA and BFW_CB. No caliper log from 0 to 100 feet below land surface.




BFW_GA
cr=50_(1-8-85)
0
50
BFW_CA
sc=in_(1-2-85)
0
20
DEPTH BELOW LAND SURFACE, IN FEET
0
50
100
150
200
250
300
350
400
450
500
550
600
No caliper log from 0 to 100 feet below land surface.
BFW_CB

Appendix J

1994 and 1995 Security Training Facility Ground Water Monitoring Information

Table J-1. 1994 and 1995 STF groundwater monitoring results.

	Monitoring Well						
	Downgradient (STF-MON-A-01A)			Upgradient (STF-MON-A-02A)			
Analyte	March 1994	April 1995	August 1995	March 1994	April 1995	August 1995	Concentration Units
Sodium	15,300 (15,400)[a]	9,870 (9,410)	9,520 (9,090)	9,100 (10,600)	16,700 (14,900)	14,400 (14,900)	µg/L
Potassium	6,600 (6,600)	2,770 (2,610)	2,320 (2,320)	5,000 U (5,000 U)	7,230 (6,090)	5,310 (5,270)	µg/L
Carbonate	NA[b]	2 U (2 U)	1 U (1 U)	NA	36.6 (56.8)	36.4 (23.8)	mg/L
Bicarbonate	NA	100 (101)	NA	27	27 (22.8)	NA	mg/L
Calcium	39,400 (44,500)	33,700 (32,200)	30,500 (30,300)	30,500 (35,600)	37,900 (31,100)	32,600 E (32,200 E)	µg/L
Magnesium	6,750 (7,840)	12,700 (12,100)	11,700 E (11,600 E)	11,500 (13,500 U)	7,350 (6,950)	5,770 E (5,830 E)	µg/L
Chloride	21	24.1 (23.8)	21.9 (22.3)	23	22.5 (20.2)	20 (19.6)	mg/L
Sulfate	32	21 (20.9)	23.1 (21.8)	19.9	30.8 (29.5)	30.3 (29.9)	mg/L
Nitrate-N	0.82	0.76 (0.75)	0.71 (0.71)	0.54	1.1 (1.0)	1.2 (1.2)	mg-N/L
Alkalinity	105	100 (101)	100 (100)	65	63.6 (79.6)	59.8 (42)	mg/L
Arsenic	10 U[c] (10 U)	1.8 (1.8 U)	2.7* (2 U)	10 U (10 U)	2.3 (3.8)	2.8* (3.2*)	µg/L
Beryllium	NA	0.7 U (0.7 U)	0.7 U (0.7 U)	NA	0.7 U (0.7 U)	0.7 U (0.7 U)	µg/L
Chromium	NA	9.2 (8.7)	5.5 (8.6)	NA	22.3 (17.1)	16.8 (15.1)	µg/L
Iron	100 U (998)	41.8 (32.7)	35.3 (37.8)	100 U (198)	149 (31.33)	109 (15.6 U)	µg/L
Lead	NA	2.5 (2.7)	1.2 (1.2)	NA	3.6 (1.5 U)	6.9 (1 U)	µg/L
Specific conductance	NA	324 (320)	319 (319)	NA	290	272	µmhos/cm
Total organic halides	8	15.1 (14.0)	13.5 (10.1)	9.8	13.2 J	9.7	mg/L
Total organic carbon	52	1.2 (2.6)	0.51 (0.7)	0.8	1.1	0.79	mg/L

Table J-1. (continued).

Analyte	Monitoring Well: Downgradient (STF-MON-A-01A) March 1994	April 1995	August 1995	Upgradient (STF-MON-A-02A) March 1994	April 1995	August 1995	Concentration Units
Total dissolved solids	174	190 (201)	208 (216)	208	164 (174)	167 (184)	mg/L
Gross alpha	—	5.4 U (5.1 U)	—	—	2 U	—	pCi/L
Gross beta	—	2.81±0.86	—	—	4 ± 0.79	—	pCi/L
Sr-90	NA	0.66 U (0.66 U)	—	NA	0.67 U	—	pCi/L
H-3	—	—	—	—	700 U	—	pCi/L
pH	NA	8.0 (6.7)	8.3 (8.3)	NA	9.8	9.3	Unitless
Acetone	NA	10 U 10 U	NA	NA	10 U	NA	µg/L
Methylene chloride	NA	12.0 U (11.0) U	5 U (7 B)	NA	5 U	6 B	µg/L

a. Results of duplicate analysis are given in parenthesis.

b. NA = not analyzed.

c. U = not detected, the value given is the detection limit.

B = the analyte is present in the associated method blank as well as in the sample.

* = duplicate analysis not within control limits.

E = reported value estimated because of interference.

Summary of 1,1,1-Trichloroethane Detected During Routine Drinking Water Sampling		
Well	Sampling Date MM/DD/YY	Concentration UG/L
BFW*	5/14/97	1.2
BFW	9/3/96	1.10
BFW	9/15/94	1.26
BFW	4/6/94	0.92
BFW	3/2/94	1.03
BFW	9/8/93	1.20
BFW	10/24/87	1.00

*Badging Facility Well

SAMPLE_NUM	LOCATION	COMPOUND_NAME	CONCENTRATION	UNITS	Rad Uncert	Q_FLAGS	Sample Date
00295151AB	STF-MON-A-001A	ALPHA	5.1	pCi/L		U	25-APR-95
00295151AB	STF-MON-A-001A	BETA	2.4	pCi/L		U	25-APR-95
00295151R4	STF-MON-A-001A	GAMMA ND		pCi/mL			25-APR-95
00295151R8	STF-MON-A-001A	Tritium	700	pCi/L		U	25-APR-95
00295151RB	STF-MON-A-001A	Sr-90	.66	pCi/L		U	25-APR-95
00295151VG	STF-MON-A-001A	1,1,1-Trichloroethane	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	1,1,2,2-Tetrachloroethane	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	1,1,2-Trichloroethane	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	1,1-Dichloroethane	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	1,1-Dichloroethene	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	1,2-Dichloroethane	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	1,2-Dichloroethene (total)	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	1,2-Dichloropropane	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	2-Butanone	10	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	2-Hexanone	10	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	4-Methyl-2-Pentanone	10	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	Acetone	10	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	Benzene	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	Bromodichloromethane	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	Bromoform	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	Bromomethane	10	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	Carbon Disulfide	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	Carbon Tetrachloride	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	Chlorobenzene	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	Chloroethane	10	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	Chloroform	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	Chloromethane	10	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	Dibromochloromethane	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	Ethylbenzene	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	Methylene Chloride	11	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	Styrene	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	Tetrachloroethene	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	Toluene	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	Trichloroethene	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	Vinyl Acetate	10	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	Vinyl Chloride	10	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	Xylene (total)	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	cis-1,3-Dichloropropene	5	ug/L		U	25-APR-95
00295151VG	STF-MON-A-001A	trans-1,3-Dichloropropene	5	ug/L		U	25-APR-95
00295152AB	STF-MON-A-001A	ALPHA	5.4	pCi/L		U	25-APR-95
00295152AB	STF-MON-A-001A	BETA	2.81	pCi/L	.86		25-APR-95
00295152R4	STF-MON-A-001A	GAMMA ND		pCi/mL			25-APR-95
00295152R8	STF-MON-A-001A	Tritium	700	pCi/L		U	25-APR-95
00295152RB	STF-MON-A-001A	Sr-90	.66	pCi/L		U	25-APR-95
00295152VG	STF-MON-A-001A	1,1,1-Trichloroethane	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	1,1,2,2-Tetrachloroethane	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	1,1,2-Trichloroethane	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	1,1-Dichloroethane	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	1,1-Dichloroethene	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	1,2-Dichloroethane	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	1,2-Dichloroethene (total)	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	1,2-Dichloropropane	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	2-Butanone	10	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	2-Hexanone	10	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	4-Methyl-2-Pentanone	10	ug/L		U	25-APR-95

SAMPLE_NUM	LOCATION	COMPOUND_NAME	CONCENTRATION	UNITS	Rad Uncert	Q_FLAGS	Sample Date
00295152VG	STF-MON-A-001A	Acetone	10	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	Benzene	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	Bromodichloromethane	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	Bromoform	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	Bromomethane	10	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	Carbon Disulfide	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	Carbon Tetrachloride	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	Chlorobenzene	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	Chloroethane	10	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	Chloroform	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	Chloromethane	10	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	Dibromochloromethane	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	Ethylbenzene	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	Methylene Chloride	12	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	Styrene	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	Tetrachloroethene	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	Toluene	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	Trichloroethene	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	Vinyl Acetate	10	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	Vinyl Chloride	10	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	Xylene (total)	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	cis-1,3-Dichloropropene	5	ug/L		U	25-APR-95
00295152VG	STF-MON-A-001A	trans-1,3-Dichloropropene	5	ug/L		U	25-APR-95
05095151AB	STF-MON-A-001A	ALPHA	2.2	pCi/L		U	01-AUG-95
05095151AB	STF-MON-A-001A	BETA	1.9	pCi/L		U	01-AUG-95
05095151R4	STF-MON-A-001A	GAMMA ND		pCi/L			02-AUG-95
05095151R8	STF-MON-A-001A	Tritium	430	pCi/L		U	01-AUG-95
05095151RB	STF-MON-A-001A	Sr-90	.56	pCi/L		U	01-AUG-95
05095151VG	STF-MON-A-001A	1,1,1-Trichloroethane	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	1,1,2,2-Tetrachloroethane	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	1,1,2-Trichloroethane	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	1,1-Dichloroethane	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	1,1-Dichloroethene	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	1,2-Dichloroethane	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	1,2-Dichloroethene (total)	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	1,2-Dichloropropane	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	2-Butanone	10	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	2-Hexanone	10	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	4-Methyl-2-Pentanone	10	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	Acetone	10	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	Benzene	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	Bromodichloromethane	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	Bromoform	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	Bromomethane	10	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	Carbon Disulfide	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	Carbon Tetrachloride	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	Chlorobenzene	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	Chloroethane	10	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	Chloroform	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	Chloromethane	10	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	Dibromochloromethane	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	Ethylbenzene	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	Methylene Chloride	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	Styrene	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	Tetrachloroethene	5	ug/L		U	02-AUG-95

SAMPLE_NUM	LOCATION	COMPOUND_NAME	ON	UNITS	Rad Uncert	Q_FLAGS	Sample Date
05095151VG	STF-MON-A-001A	Toluene	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	Trichloroethene	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	Vinyl Acetate	10	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	Vinyl Chloride	10	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	Xylene (total)	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	cis-1,3-Dichloropropene	5	ug/L		U	02-AUG-95
05095151VG	STF-MON-A-001A	trans-1,3-Dichloropropene	5	ug/L		U	02-AUG-95
05095152AB	STF-MON-A-001A	ALPHA	.3	pCi/L		U	01-AUG-95
05095152AB	STF-MON-A-001A	BETA	33	pCi/L	.68		01-AUG-95
05095152R4	STF-MON-A-001A	GAMMA ND		pCi/L			02-AUG-95
05095152R8	STF-MON-A-001A	Tritium	30	pCi/L		U	01-AUG-95
05095152RB	STF-MON-A-001A	Sr-90	57	pCi/L		U	01-AUG-95
05095152VG	STF-MON-A-001A	1,1,1-Trichloroethane	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	1,1,2,2-Tetrachloroethane	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	1,1,2-Trichloroethane	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	1,1-Dichloroethane	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	1,1-Dichloroethene	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	1,2-Dichloroethane	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	1,2-Dichloroethene (total)	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	1,2-Dichloropropane	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	2-Butanone	10	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	2-Hexanone	10	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	4-Methyl-2-Pentanone	10	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	Acetone	10	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	Benzene	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	Bromodichloromethane	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	Bromoform	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	Bromomethane	10	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	Carbon Disulfide	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	Carbon Tetrachloride	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	Chlorobenzene	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	Chloroethane	10	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	Chloroform	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	Chloromethane	10	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	Dibromochloromethane	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	Ethylbenzene	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	Methylene Chloride	7	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	Styrene	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	Tetrachloroethene	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	Toluene	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	Trichloroethene	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	Vinyl Acetate	10	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	Vinyl Chloride	10	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	Xylene (total)	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	cis-1,3-Dichloropropene	5	ug/L		U	02-AUG-95
05095152VG	STF-MON-A-001A	trans-1,3-Dichloropropene	5	ug/L		U	02-AUG-95
00295161AB	STF-MON-A-002A	ALPHA	2	pCi/L		J	24-APR-95
00295161AB	STF-MON-A-002A	BETA	4	pCi/L	.79		24-APR-95
00295161R4	STF-MON-A-002A	GAMMA ND		pCi/mL			24-APR-95
00295161R8	STF-MON-A-002A	Tritium	00	pCi/L		U	24-APR-95
00295161RB	STF-MON-A-002A	Sr-90	67	pCi/L		U	24-APR-95
00295161VG	STF-MON-A-002A	1,1,1-Trichloroethane	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	1,1,2,2-Tetrachloroethane	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	1,1,2-Trichloroethane	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	1,1-Dichloroethane	5	ug/L		U	24-APR-95

SAMPLE_NUM	LOCATION	COMPOUND_NAME	CONCENTRATION	UNITS	Rad Uncert	Q_FLAGS	Sample Date
00295161VG	STF-MON-A-002A	1,1-Dichloroethene	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	1,2-Dichloroethane	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	1,2-Dichloroethene (total)	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	1,2-Dichloropropane	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	2-Butanone	10	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	2-Hexanone	10	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	4-Methyl-2-Pentanone	10	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	Acetone	10	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	Benzene	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	Bromodichloromethane	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	Bromoform	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	Bromomethane	10	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	Carbon Disulfide	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	Carbon Tetrachloride	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	Chlorobenzene	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	Chloroethane	10	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	Chloroform	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	Chloromethane	10	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	Dibromochloromethane	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	Ethylbenzene	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	Methylene Chloride	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	Styrene	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	Tetrachloroethene	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	Toluene	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	Trichloroethene	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	Vinyl Acetate	10	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	Vinyl Chloride	10	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	Xylene (total)	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	cis-1,3-Dichloropropene	5	ug/L		U	24-APR-95
00295161VG	STF-MON-A-002A	trans-1,3-Dichloropropene	5	ug/L		U	24-APR-95
05095161AB	STF-MON-A-002A	ALPHA	2.4	pCi/L		U	01-AUG-95
05095161AB	STF-MON-A-002A	BETA	5.78	pCi/L	.93		01-AUG-95
05095161R4	STF-MON-A-002A	GAMMA ND		pCi/L			03-AUG-95
05095161R8	STF-MON-A-002A	Tritium	430	pCi/L		U	01-AUG-95
05095161RB	STF-MON-A-002A	Sr-90	.57	pCi/L		U	01-AUG-95
05095161VG	STF-MON-A-002A	1,1,1-Trichloroethane	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	1,1,2,2-Tetrachloroethane	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	1,1,2-Trichloroethane	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	1,1-Dichloroethane	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	1,1-Dichloroethene	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	1,2-Dichloroethane	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	1,2-Dichloroethene (total)	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	1,2-Dichloropropane	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	2-Butanone	10	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	2-Hexanone	10	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	4-Methyl-2-Pentanone	10	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	Acetone	10	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	Benzene	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	Bromodichloromethane	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	Bromoform	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	Bromomethane	10	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	Carbon Disulfide	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	Carbon Tetrachloride	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	Chlorobenzene	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	Chloroethane	10	ug/L		U	03-AUG-95

SAMPLE_NUM	LOCATION	COMPOUND_NAME	CONCENTRATION	UNITS	Rad Uncert	Q_FLAGS	Sample Date
05095161VG	STF-MON-A-002A	Chloroform	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	Chloromethane	10	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	Dibromochloromethane	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	Ethylbenzene	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	Methylene Chloride	6	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	Styrene	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	Tetrachloroethene	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	Toluene	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	Trichloroethene	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	Vinyl Acetate	10	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	Vinyl Chloride	10	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	Xylene (total)	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	cis-1,3-Dichloropropene	5	ug/L		U	03-AUG-95
05095161VG	STF-MON-A-002A	trans-1,3-Dichloropropene	5	ug/L		U	03-AUG-95

509 rows selected.

SQL> spool off

SAMPLE_NUM	AREA	LOCATION	TYPE_LOCATION	COMPOUND_NAME	CONC	ION	UNITS	Q	Sample Date
RIS61001VT	OUTSIDE RWMC	9302 - PORT 1	MONITORING WELL	1,1,1-Trichloroethane		2.7	ppmv	J	12-JUL-95
1TPA1001DM	MW-2	AFTER PURGE	MW-2	1,1,1-Trichloroethane		.3	ug/L	J	11-JUN-96
A0300107TF	ARA-I	ARA-03	SOILS	1,1,1-Trichloroethane		1	ug/L	J	01-MAY-91
1TPA0901DV	MW-2	BEFORE PURGE	MW-2	1,1,1-Trichloroethane		.2	ug/L	J	11-JUN-96
4CQ11101D7	CFA	CFA-1	LANDFILL II	1,1,1-Trichloroethane		.4	ug/L	J	05-AUG-93
4CQ01201D4	CFA	CFA-2	LANDFILL II	1,1,1-Trichloroethane		.3	ug/L	J	08-JUN-93
4CQ11201D7	CFA	CFA-2	LANDFILL II	1,1,1-Trichloroethane		.2	ug/L	J	05-AUG-93
4MQ01301VG	CFA	CFA-MON-002	AQUIFER WELL	1,1,1-Trichloroethane		.2	ug/L	J	12-JUL-96
4MQ06201VG	CFA	CFA-MON-002	AQUIFER WELL	1,1,1-Trichloroethane		.2	ug/L	J	17-OCT-96
4MQ01401VG	CFA	CFA-MON-003	AQUIFER WELL	1,1,1-Trichloroethane		.1	ug/L	J	12-JUL-96
3PG00701DV	ICPP	CPP 55-06	MONITORING WELL	1,1,1-Trichloroethane		.2	ug/L	J	08-DEC-93
CPP333150	ICPP	CPP33-3	BOREHOLE	1,1,1-Trichloroethane		16	ug/L		31-OCT-90
RIS60901VT	OUTSIDE RWMC	D02 - PORT 3	MONITORING WELL	1,1,1-Trichloroethane		48	ppmv	J	12-JUL-95
RIS60901VTDL	OUTSIDE RWMC	D02 - PORT 3	MONITORING WELL	1,1,1-Trichloroethane		44	ppmv	J	12-JUL-95
4MQ00801VG	CFA	LF 2-10	AQUIFER WELL	1,1,1-Trichloroethane		.1	ug/L	J	11-JUL-96
4MQ00301VF	CFA	LF 2-11	AQUIFER WELL	1,1,1-Trichloroethane		.3	ug/L	J	11-JUL-96
4MQ05201VF	CFA	LF 2-11	AQUIFER WELL	1,1,1-Trichloroethane		.2	ug/L	J	17-OCT-96
4MQ00101VG	CFA	LF 2-8	AQUIFER WELL	1,1,1-Trichloroethane		.3	ug/L	J	11-JUL-96
4MQ05001VG	CFA	LF 2-8	AQUIFER WELL	1,1,1-Trichloroethane		.2	ug/L	J	17-OCT-96
4MQ00201VG	CFA	LF 2-9	AQUIFER WELL	1,1,1-Trichloroethane		.3	ug/L	J	11-JUL-96
4MQ05101VG	CFA	LF 2-9	AQUIFER WELL	1,1,1-Trichloroethane		.2	ug/L	J	17-OCT-96
4MQ00601VG	CFA	LF 3-10	AQUIFER WELL	1,1,1-Trichloroethane		.2	ug/L	J	11-JUL-96
4MQ05501VG	CFA	LF 3-10	AQUIFER WELL	1,1,1-Trichloroethane		.2	ug/L	J	18-OCT-96
4MQ00401VG	CFA	LF 3-8	AQUIFER WELL	1,1,1-Trichloroethane		.3	ug/L	J	12-JUL-96
4MQ00402VG	CFA	LF 3-8	AQUIFER WELL	1,1,1-Trichloroethane		.3	ug/L	J	12-JUL-96
4MQ05301VG	CFA	LF 3-8	AQUIFER WELL	1,1,1-Trichloroethane		.3	ug/L	J	18-OCT-96
4MQ05302VG	CFA	LF 3-8	AQUIFER WELL	1,1,1-Trichloroethane		.3	ug/L	J	18-OCT-96
4MQ00501VG	CFA	LF 3-9	AQUIFER WELL	1,1,1-Trichloroethane		.3	ug/L	J	29-JUL-96
4CQ10301D7	CFA	LF2-10	LANDFILL II	1,1,1-Trichloroethane		.3	ug/L	J	20-AUG-93
4CQ10301D7RE	CFA	LF2-10	LANDFILL II	1,1,1-Trichloroethane		.3	ug/L	J	20-AUG-93
4CQ20301D7	CFA	LF2-10	LANDFILL II	1,1,1-Trichloroethane		.3	ug/L	J	20-OCT-93
4CQ00401D4	CFA	LF2-11	LANDFILL II	1,1,1-Trichloroethane		.3	ug/L	J	02-JUN-93
4CQ10401D4	CFA	LF2-11	LANDFILL II	1,1,1-Trichloroethane		.2	ug/L	J	05-AUG-93
4CQ10501D4	CFA	LF2-12	LANDFILL II	1,1,1-Trichloroethane		.2	ug/L	J	05-AUG-93
4CQ00101D4	CFA	LF2-8	LANDFILL II	1,1,1-Trichloroethane		.4	ug/L	J	07-JUN-93
4CQ20101D7	CFA	LF2-8	LANDFILL II	1,1,1-Trichloroethane		.5	ug/L	J	19-OCT-93
4CQ00201D4	CFA	LF2-9	LANDFILL II	1,1,1-Trichloroethane		.4	ug/L	J	07-JUN-93
4CQ10201D7	CFA	LF2-9	LANDFILL II	1,1,1-Trichloroethane		5	ug/L	J	10-AUG-93
4CQ00801D4	CFA	LF3-10	LANDFILL III	1,1,1-Trichloroethane		.3	ug/L	J	02-JUN-93
4CQ10801D4	CFA	LF3-10	LANDFILL III	1,1,1-Trichloroethane		.3	ug/L	J	04-AUG-93
4CQ10901D4	CFA	LF3-11	LANDFILL III	1,1,1-Trichloroethane		.2	ug/L	J	04-AUG-93
4CQ00601D4	CFA	LF3-8	LANDFILL III	1,1,1-Trichloroethane		.3	ug/L	J	07-JUN-93
4CQ10601D7	CFA	LF3-8	LANDFILL III	1,1,1-Trichloroethane		.3	ug/L	J	20-AUG-93
4CQ10601D7RE	CFA	LF3-8	LANDFILL III	1,1,1-Trichloroethane		.3	ug/L	J	20-AUG-93
4CQ20601D7	CFA	LF3-8	LANDFILL III	1,1,1-Trichloroethane		.5	ug/L	J	20-OCT-93
4CQ00701D4	CFA	LF3-9	LANDFILL III	1,1,1-Trichloroethane		.4	ug/L	J	20-MAY-93
4CQ10701D4	CFA	LF3-9	LANDFILL III	1,1,1-Trichloroethane		.3	ug/L	J	02-AUG-93
RIS20601D4	OUTSIDE RWMC	M10S	MONITORING WELL	1,1,1-Trichloroethane		.1	ug/L	J	28-JUL-93
RIS25501D4	OUTSIDE RWMC	M10S	MONITORING WELL	1,1,1-Trichloroethane		.3	ug/L	J	04-NOV-93
RIS30601D4	OUTSIDE RWMC	M10S	MONITORING WELL	1,1,1-Trichloroethane		.2	ug/L	J	17-JAN-94
RIS30601D4RE	OUTSIDE RWMC	M10S	MONITORING WELL	1,1,1-Trichloroethane		.3	ug/L	J	17-JAN-94
RIS45501D4	OUTSIDE RWMC	M10S	MONITORING WELL	1,1,1-Trichloroethane		.3	ug/L	J	02-NOV-94
RIS50601VF	OUTSIDE RWMC	M10S	MONITORING WELL	1,1,1-Trichloroethane		.3	ug/L	J	12-JAN-95
RIS55501VF	OUTSIDE RWMC	M10S	MONITORING WELL	1,1,1-Trichloroethane		.4	ug/L	J	18-APR-95
RIS60601VF	OUTSIDE RWMC	M10S	MONITORING WELL	1,1,1-Trichloroethane		.6	ug/L	J	18-JUL-95

SAMPLE_NUM	AREA	LOCATION	TYPE_LOCATION	COMPOUND_NAME	CONCENTRATION	UNITS	Q Flags	Sample Date
RIS68001VF	RMMC AREA	M10S	MONITORING WELL	1,1,1-Trichloroethane	1	ug/L	BJ	02-APR-96
RIS25001D4	OUTSIDE RMMC	M1S	MONITORING WELL	1,1,1-Trichloroethane	.4	ug/L	J	04-NOV-93
RIS67501VG	RMMC AREA	M1S	MONITORING WELL	1,1,1-Trichloroethane	1	ug/L	BJ	02-APR-96
RIS10201D4	OUTSIDE RMMC	M3S	MONITORING WELL	1,1,1-Trichloroethane	.2	ug/L	J	26-FEB-93
RIS10202D4	OUTSIDE RMMC	M3S	MONITORING WELL	1,1,1-Trichloroethane	.3	ug/L	J	26-FEB-93
RIS20201D4	OUTSIDE RMMC	M3S	MONITORING WELL	1,1,1-Trichloroethane	.2	ug/L	J	28-JUL-93
RIS25101D4	OUTSIDE RMMC	M3S	MONITORING WELL	1,1,1-Trichloroethane	.3	ug/L	J	05-NOV-93
RIS30201D4	OUTSIDE RMMC	M3S	MONITORING WELL	1,1,1-Trichloroethane	.2	ug/L	J	18-JAN-94
RIS45101D4	OUTSIDE RMMC	M3S	MONITORING WELL	1,1,1-Trichloroethane	.3	ug/L	J	02-NOV-94
RIS50201VG	OUTSIDE RMMC	M3S	MONITORING WELL	1,1,1-Trichloroethane	.2	ug/L	J	12-JAN-95
RIS55101VG	OUTSIDE RMMC	M3S	MONITORING WELL	1,1,1-Trichloroethane	.2	ug/L	J	19-APR-95
RIS60201VG	OUTSIDE RMMC	M3S	MONITORING WELL	1,1,1-Trichloroethane	.3	ug/L	J	18-JUL-95
RIS67601VG	RMMC AREA	M3S	MONITORING WELL	1,1,1-Trichloroethane	1	ug/L	BJ	02-APR-96
RISA0201VG	RMMC AREA	M3S	MONITORING WELL	1,1,1-Trichloroethane	.2	ug/L	J	25-SEP-96
RISC5201VG	RMMC AREA	M3S	MONITORING WELL	1,1,1-Trichloroethane	.2	ug/L	J	14-JUL-97
RIS10401D4	OUTSIDE RMMC	M6S	MONITORING WELL	1,1,1-Trichloroethane	.4	ug/L	J	04-MAR-93
RIS20401D4	OUTSIDE RMMC	M6S	MONITORING WELL	1,1,1-Trichloroethane	.3	ug/L	J	28-JUL-93
RIS20402D4	OUTSIDE RMMC	M6S	MONITORING WELL	1,1,1-Trichloroethane	.3	ug/L	J	28-JUL-93
RIS25301D4	OUTSIDE RMMC	M6S	MONITORING WELL	1,1,1-Trichloroethane	.3	ug/L	J	05-NOV-93
RIS30401D4	OUTSIDE RMMC	M6S	MONITORING WELL	1,1,1-Trichloroethane	.2	ug/L	J	18-JAN-94
RIS35301D4	OUTSIDE RMMC	M6S	MONITORING WELL	1,1,1-Trichloroethane	.3	ug/L	J	18-APR-94
RIS45301D4	OUTSIDE RMMC	M6S	MONITORING WELL	1,1,1-Trichloroethane	.4	ug/L	J	02-NOV-94
RIS50401VG	OUTSIDE RMMC	M6S	MONITORING WELL	1,1,1-Trichloroethane	.2	ug/L	J	11-JAN-95
RIS55301VG	OUTSIDE RMMC	M6S	MONITORING WELL	1,1,1-Trichloroethane	.3	ug/L	J	18-APR-95
RIS60401VG	OUTSIDE RMMC	M6S	MONITORING WELL	1,1,1-Trichloroethane	.4	ug/L	J	18-JUL-95
RISA0401VG	RMMC AREA	M6S	MONITORING WELL	1,1,1-Trichloroethane	.2	ug/L	J	25-SEP-96
RIS60801VT	OUTSIDE RMMC	M6S - PORT 1	MONITORING WELL	1,1,1-Trichloroethane	.18	ppmv	J	10-JUL-95
RIS10501D4	OUTSIDE RMMC	M7S	MONITORING WELL	1,1,1-Trichloroethane	.8	ug/L	J	04-MAR-93
RIS10502D4	OUTSIDE RMMC	M7S	MONITORING WELL	1,1,1-Trichloroethane	.9	ug/L	J	04-MAR-93
RIS20501D4	OUTSIDE RMMC	M7S	MONITORING WELL	1,1,1-Trichloroethane	.6	ug/L	J	27-JUL-93
RIS20502D4	OUTSIDE RMMC	M7S	MONITORING WELL	1,1,1-Trichloroethane	.6	ug/L	J	27-JUL-93
RIS25401D4	OUTSIDE RMMC	M7S	MONITORING WELL	1,1,1-Trichloroethane	.9	ug/L	J	09-NOV-93
RIS25402D4	OUTSIDE RMMC	M7S	MONITORING WELL	1,1,1-Trichloroethane	.7	ug/L	J	09-NOV-93
RIS30501D4	OUTSIDE RMMC	M7S	MONITORING WELL	1,1,1-Trichloroethane	.8	ug/L	J	18-JAN-94
RIS30502D4	OUTSIDE RMMC	M7S	MONITORING WELL	1,1,1-Trichloroethane	.7	ug/L	J	18-JAN-94
RIS35401D4	OUTSIDE RMMC	M7S	MONITORING WELL	1,1,1-Trichloroethane	.8	ug/L	J	18-APR-94
RIS35402D4	OUTSIDE RMMC	M7S	MONITORING WELL	1,1,1-Trichloroethane	.8	ug/L	J	18-APR-94
RIS45401D4	OUTSIDE RMMC	M7S	MONITORING WELL	1,1,1-Trichloroethane	.6	ug/L	J	02-NOV-94
RIS45402D4	OUTSIDE RMMC	M7S	MONITORING WELL	1,1,1-Trichloroethane	.8	ug/L	J	02-NOV-94
RIS50501VG	OUTSIDE RMMC	M7S	MONITORING WELL	1,1,1-Trichloroethane	.7	ug/L	J	12-JAN-95
RIS50502VG	OUTSIDE RMMC	M7S	MONITORING WELL	1,1,1-Trichloroethane	.7	ug/L	J	12-JAN-95
RIS55401VG	OUTSIDE RMMC	M7S	MONITORING WELL	1,1,1-Trichloroethane	.5	ug/L	J	19-APR-95
RIS55402VG	OUTSIDE RMMC	M7S	MONITORING WELL	1,1,1-Trichloroethane	.6	ug/L	J	19-APR-95
RIS60501VG	OUTSIDE RMMC	M7S	MONITORING WELL	1,1,1-Trichloroethane	.7	ug/L	J	18-JUL-95
RIS60502VG	OUTSIDE RMMC	M7S	MONITORING WELL	1,1,1-Trichloroethane	.7	ug/L	J	18-JUL-95
RIS65401VG	RMMC AREA	M7S	MONITORING WELL	1,1,1-Trichloroethane	4	ug/L	J	03-OCT-95
RIS67901VG	RMMC AREA	M7S	MONITORING WELL	1,1,1-Trichloroethane	1	ug/L	BJ	02-APR-96
RISA0501VG	RMMC AREA	M7S	MONITORING WELL	1,1,1-Trichloroethane	.7	ug/L	J	25-SEP-96
RISA0502VG	RMMC AREA	M7S	MONITORING WELL	1,1,1-Trichloroethane	.7	ug/L	J	25-SEP-96
PURGETEST	RMMC AREA	M7S	MONITORING WELL	1,1,1-Trichloroethane	.06	ug/L	J	25-FEB-97
RISC0501VG	RMMC AREA	M7S	MONITORING WELL	1,1,1-Trichloroethane	.6	ug/L	J	25-FEB-97
RISC0502VG	RMMC AREA	M7S	MONITORING WELL	1,1,1-Trichloroethane	.7	ug/L	J	25-FEB-97
RISA5501VG	RMMC AREA	M7S	MONITORING WELL	1,1,1-Trichloroethane	.7	ug/L	J	09-APR-97
RISA5502VGRE	RMMC AREA	M7S	MONITORING WELL	1,1,1-Trichloroethane	.7	ug/L	J	09-APR-97
RISA5502VG	RMMC AREA	M7S	MONITORING WELL	1,1,1-Trichloroethane	.7	ug/L	J	09-APR-97

SAMPLE_NUM	AREA	LOCATION	TYPE_LOCATION	COMPOUND_NAME	CONCENTRATION	UNITS	Q Flags	Sample Date
RISA5501VGRE	RWMC AREA	M7S	MONITORING WELL	1,1,1-Trichloroethane	.7	ug/L	J	09-APR-97
RISC5501VG	RWMC AREA	M7S	MONITORING WELL	1,1,1-Trichloroethane	.7	ug/L	J	14-JUL-97
RISC5502VG	RWMC AREA	M7S	MONITORING WELL	1,1,1-Trichloroethane	.7	ug/L	J	14-JUL-97
RIS61101VT	OUTSIDE RWMC	M7S - PORT 1	MONITORING WELL	1,1,1-Trichloroethane	.43	ppmv		10-JUL-95
3PG00901DV	ICPP	MW-1	MONITORING WELL	1,1,1-Trichloroethane	.7	ug/L	J	09-DEC-93
CPP335110	ICPP	NOT AVAILABLE	NOT AVAILABLE	1,1,1-Trichloroethane	20	ug/L		13-DEC-90
RPL01701FV	RWMC	PA01-L15	LYSIMETER	1,1,1-Trichloroethane	5500	ug/L		29-APR-97
RPL01801FV	RWMC	PA02-L16	LYSIMETER	1,1,1-Trichloroethane	21	ug/L		29-APR-97
2P039010A	TRA PERCHD	PW-10	GROUNDWATER	1,1,1-Trichloroethane	.2	ug/L	J	14-FEB-91
2P040010A	TRA PERCHD	PW-11	GROUNDWATER	1,1,1-Trichloroethane	.2	ug/L	J	07-FEB-91
2P041010A	TRA PERCHD	PW-12	GROUNDWATER	1,1,1-Trichloroethane	6.3	ug/L		14-FEB-91
1TQ40101D4	TAN	TAN D-1	WELL-QUARTER 1	1,1,1-Trichloroethane	1	ug/L		29-MAR-94
1TQ45101D4	TAN	TAN D-2	WELL-QUARTER 2	1,1,1-Trichloroethane	.2	ug/L	J	30-JUN-94
1TQB0301VF	TAN	TAN-28	WELL	1,1,1-Trichloroethane	.3	ug/L	J	19-DEC-94
1TQB0501VG	TAN	TAN-29	WELL	1,1,1-Trichloroethane	.3	ug/L	J	20-DEC-94
1WM30201VF	TAN	TAN-33	MONITORING WELL	1,1,1-Trichloroethane	4	ug/L	J	06-FEB-97
1WM20601VG	TAN	TAN-4	MONITORING WELL	1,1,1-Trichloroethane	2	ug/L	J	13-AUG-96
1TQ40301D4	TAN	TAN-9	WELL-QUARTER 1	1,1,1-Trichloroethane	.2	ug/L	J	25-MAR-94
2R104010A	CHEM POND	TRA-06-01	GROUNDWATER	1,1,1-Trichloroethane	.2	ug/L	J	06-FEB-91
2Q041010A	TRA AQ WELL	TRA-07	GROUNDWATER	1,1,1-Trichloroethane	.3	ug/L	J	11-FEB-91
2Q042010A	TRA AQ WELL	TRA-08	GROUNDWATER	1,1,1-Trichloroethane	.3	ug/L	J	12-FEB-91
2Q044010A1	TRA AQ WELL	TRA-08	GROUNDWATER	1,1,1-Trichloroethane	.3	ug/L	J	12-FEB-91
2Q044010AS	TRA AQ WELL	TRA-08	GROUNDWATER	1,1,1-Trichloroethane	.3	ug/L	J	12-FEB-91
TSF2604C	TSF	TSFAG 5	EXISTING WELL	1,1,1-Trichloroethane	5	ug/L	R	21-NOV-90
TSF2504C	TSF	TSFAG 7	EXISTING WELL	1,1,1-Trichloroethane	5	ug/L	R	21-NOV-90
1TQ40801D4	TAN	USGS-24	WELL-QUARTER 1	1,1,1-Trichloroethane	.3	ug/L	J	30-MAR-94
1TQ50801D4	TAN	USGS-24	WELL-QUARTER 3	1,1,1-Trichloroethane	4	ug/L		17-OCT-94
1WM01701VG	TAN	USGS-24	MONITORING WELL	1,1,1-Trichloroethane	9	ug/L		15-MAY-96
1BR03901VG	TAN	USGS-24	MONITORING WELL	1,1,1-Trichloroethane	4	ug/L	J	20-AUG-96
4CQ01001D4	CFA	USGS-85	LANDFILL III	1,1,1-Trichloroethane	.5	ug/L	J	01-JUN-93
4CQ11001D7	CFA	USGS-85	LANDFILL III	1,1,1-Trichloroethane	.2	ug/L	J	03-AUG-93
4CQ21001D7	CFA	USGS-85	LANDFILL III	1,1,1-Trichloroethane	.3	ug/L	J	19-OCT-93
4MQ00701VG	CFA	USGS-85	AQUIFER WELL	1,1,1-Trichloroethane	.2	ug/L	J	11-JUL-96
RPL02901FV	RWMC	W06-L27	LYSIMETER	1,1,1-Trichloroethane	6.2	ug/L		22-APR-97
RPL01501FV	RWMC	W08-L13	LYSIMETER	1,1,1-Trichloroethane	13	ug/L		22-APR-97
RPL01301FV	RWMC	W23-L09	LYSIMETER	1,1,1-Trichloroethane	2.5	ug/L		22-APR-97
RPL03001FV	RWMC	W25-L28	LYSIMETER	1,1,1-Trichloroethane	86	ug/L		22-APR-97

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Appendix K

INEEL and Surrounding Area Hydrology

CONTENTS

FIGURES

TABLES

ACRONYMS

CFA	Central Facilities Area
CGWA	critical groundwater area
bls	below land surface
DOE	U.S. Department of Energy
EOCR	Environmental Organic-Cooled Reactor
ERB-II	Experimental Breeder Reactor No. 2
ESRP	Eastern Snake River Plain
FR	Federal Register
GWMA	groundwater management areas
ICPP	Idaho Chemical Processing Plant
IDWR	Idaho Department of Water Resources
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
LCCDA	Liquid Corrosive Chemical Disposal Area
msl	mean sea level
NRF	Naval Reactor Facility
OMRE	Organic-Moderated Reactor Experiment
OU	operable unit
PBF	Power Burst Facility
RWMC	Radioactive Waste Management Complex
SRP	Snake River Plain
SRPA	Snake River Plain Aquifer
STF	Security Training Facility
TAN	Test Area North
TRA	Test Reactor Area

USGS	United States Geological Survey

Appendix K

INEEL and Surrounding Area Hydrology

K-1. INTRODUCTION

This section provides comprehensive and detailed summary of the Idaho National Engineering and Environmental Laboratory (INEEL) and surrounding area hydrology. It summarizes previous work performed by both the United States Geological Survey (USGS) and site contractors. A brief overview of the hydrology at the INEEL and a discussion of the hydrology in the vicinity of the Operable Unit (OU) 10-04 sites to be characterized can be found in Section 2 of the OU 10-04 work plan. The purpose of this appendix is to provide the reader detailed information on the aquifer that will provide an understanding of how contaminants move through the aquifer and a basis for the development of transport conceptual models.

K-2. REGIONAL OVERVIEW

The 90,650 km^2 (35,000 mi^2) upper Snake River basin extends from its head waters in Yellowstone National Park in northwest Wyoming to King Hill in south-central Idaho (Figure K-1). Twenty-four major subbasins are tributary to the Snake River (Low 1991). The altitude of the Snake River in Wyoming ranges from approximately 2,073 m (6,800 ft) above sea level near Jackson Lake in Grand Teton National Park to approximately 1,737 m (5,700 ft) near Palisades Reservoir on the Idaho/Wyoming border, approximately 155 km (96 mi) downstream. Surrounding mountains are as high as 4,197 m (13,770 ft) above sea level. The altitude of the Snake River in Idaho ranges from about 1,645 m (5,400 ft) above sea level at the outflow of Palisades Reservoir to 762 m (2,500 ft) at King Hill, approximately 567 km (354 mi) downstream.

The 27,972 km^2 (10,800 mi^2) Eastern Snake River Plain (ESRP) is approximately 97 km (60 mi) wide and 274 km (170 mi) long. The plain is underlain by a highly transmissive water table basalt aquifer named the Snake River Plain Aquifer (SRPA). Large areas of the plain are bare basalt with little or no vegetation. The plain ranges in altitude from approximately 1,829 m (6,000 ft) in the northeast to 762 m (2,500 ft) at King Hill. Precipitation amounts range widely throughout the basin. Average annual precipitation ranges from about 25 cm (10 in.) on the SRP to 127 cm (50 in.) on the surrounding mountains (USGS 1986).

K-2.1 Surface Water

The INEEL is located in the ESRP in southeastern Idaho at an average elevation of 1,494 m (4,900 ft) above mean sea level (msl). Mountain ranges located to the west and north of the ESRP strongly influence the climate on the SRP, as does the latitude, longitude, and elevation of the SRP. Moisture in the air precipitates as snow or rainfall over the mountains, leaving little moisture available for precipitation on the SRP, creating its semiarid climate. Average annual precipitation on the INEEL is 22 cm (8.71 in.) (Clawson et al. 1989). The mountains bordering the SRP channel prevailing winds into a southwesterly direction.

Surface water hydrology at the INEEL includes water from three streams that infrequently flow onto the INEEL and from local runoff from rainfall and snowmelt. Surface water at the INEEL is almost

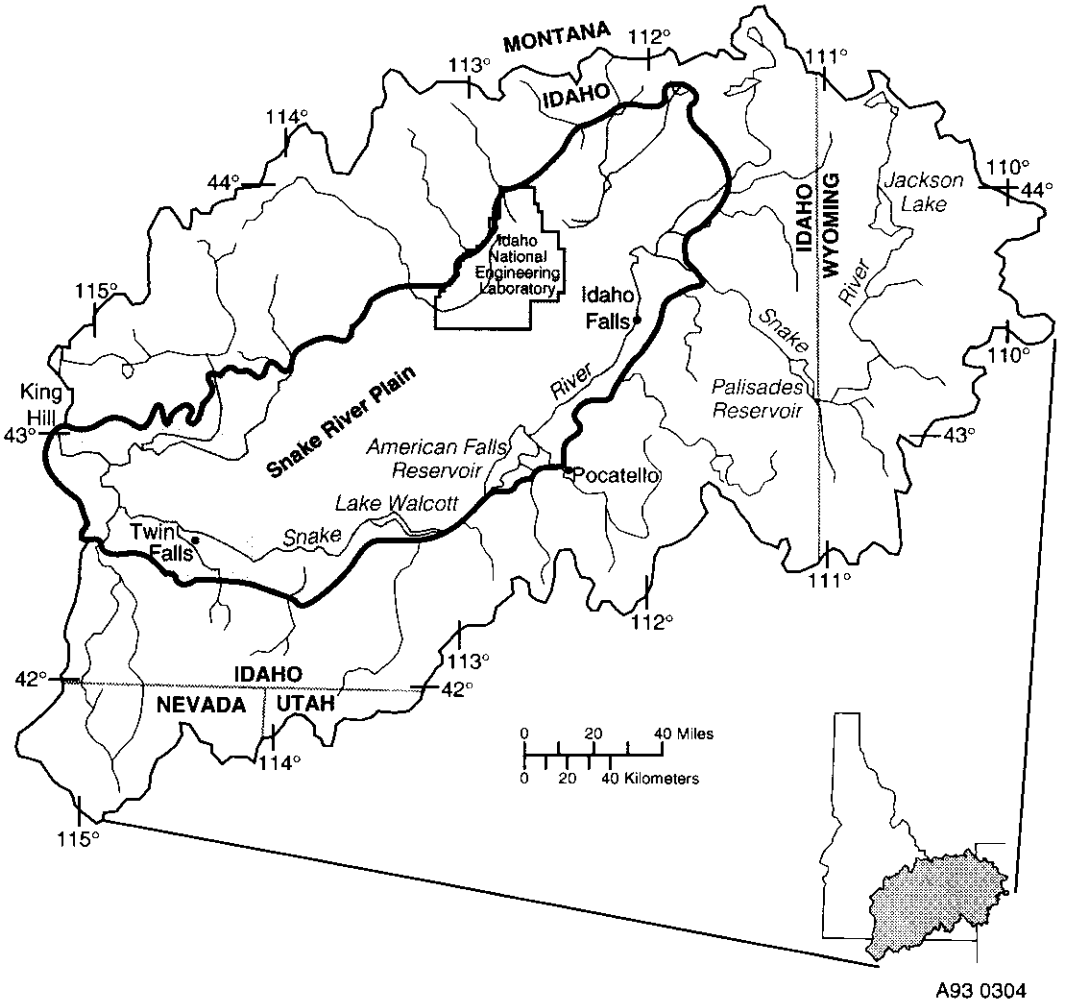


Figure K-1. The upper Snake River drainage basin.

nonexistent except in years when runoff is heavy. This generally occurs when soils are frozen and covered by a heavy snowpack and rainfall occurs on the snowpack.

K-2.1.1 Regional Drainages

Most of the INEEL is located in the Pioneer Basin. Surface water within the Pioneer Basin includes water from the Big Lost River, the Little Lost River, and Birch Creek, all of which drain mountain watersheds located to the north and northwest of the INEEL. These drainages and their relationship to INEEL are shown in Figure K-2. Stream flows are often depleted before reaching the INEEL by irrigation diversions and infiltration losses in the river channels. When water does flow onto the INEEL, it either evaporates or infiltrates into the ground because the Pioneer Basin is a closed basin (a topographic depression with no outlet).

K-2.1.1.1 Big Lost River. The Big Lost River Basin, upstream from the INEEL, contains a drainage area of about 3,626 km^2 (1,400 mi^2). As shown in Figure K-3, the 2,305 km^2 (890 mi^2) of area within the INEEL boundaries, only about 181 to 207 km^2 (70 to 80 mi^2) actually contribute surface runoff of any significance to the Big Lost River except during infrequent floods (Bennett 1990).

The Big Lost River Valley is one of the major structural intermountain basins of east-central Idaho. The head waters of the Big Lost River originate in the Lost River, Boulder, Pioneer, and White Knob Mountain ranges. The main stem of the Big Lost River is formed about 35 km (22 mi) northwest of Mackay Dam by the confluence of the Big Lost River's East Fork and North Fork. The drainage basin above Mackay Dam contains an area of 2,041 km^2 (788 mi^2).

The relationship of the INEEL and the Big Lost River, Little Lost River, and Birch Creek Basins to the Pioneer Basin is shown in Figure K-4. A profile of the Big Lost River channel over its entire length, which indicates the channel gradient, is shown in Figure K-5. Locations of interest along the profile are also shown in Figure K-5.

Within the INEEL, noncontributing areas of the Big Lost River Basin consist of small, topographically closed basins (2.6 to 26 km^2 [1 to 10 mi^2]). Land surface elevations within the Big Lost River Basin range from about 1,457 km (4,780 ft) msl at the terminal playas of the river to 3,859 km (12,662 ft) msl at Borah Peak in the Lost River Range (Bennett 1990).

The Big Lost River is the major surface water feature of the INEEL. Mackay Dam, which is located about 6 km (4 mi) northwest of Mackay and 48 km (30 mi) upstream of Arco, impounds and regulates the flows of the Big Lost River for irrigation purposes. After being discharged from Mackay Dam, water flows southeastward past Arco and onto the ESRP.

The Big Lost River channel is incised about 18 m (60 ft) into the SRP basalt from 1.6 to 3.2 km (1 to 2 mi) downstream from the gauging station near Arco. The river emerges from the narrow, 61- to 91-km (200- to 300-ft) wide canyon after reaching the western boundary of the INEEL into a broad plain where it is incised less than 6 m (20 ft). The INEEL flood control diversion dam, a low earthen dam and headgate located about 10.5 km (6.5 mi) downstream from the INEEL boundary, is used to divert water from the river into a series of natural depressions. These depressions are known as Spreading Areas A, B, C, and D (see Figure K-6). The diversion dam and channel system were constructed in 1958 and enlarged in 1984 to prevent flooding at downstream facilities (Bennett 1986; 1990).

About 9.7 km (6 mi) downstream from the INEEL diversion dam, near State Highway 20, the river channel is incised less than 3 m (10 ft) into the flood plain. The river then enters a broad flood plain that

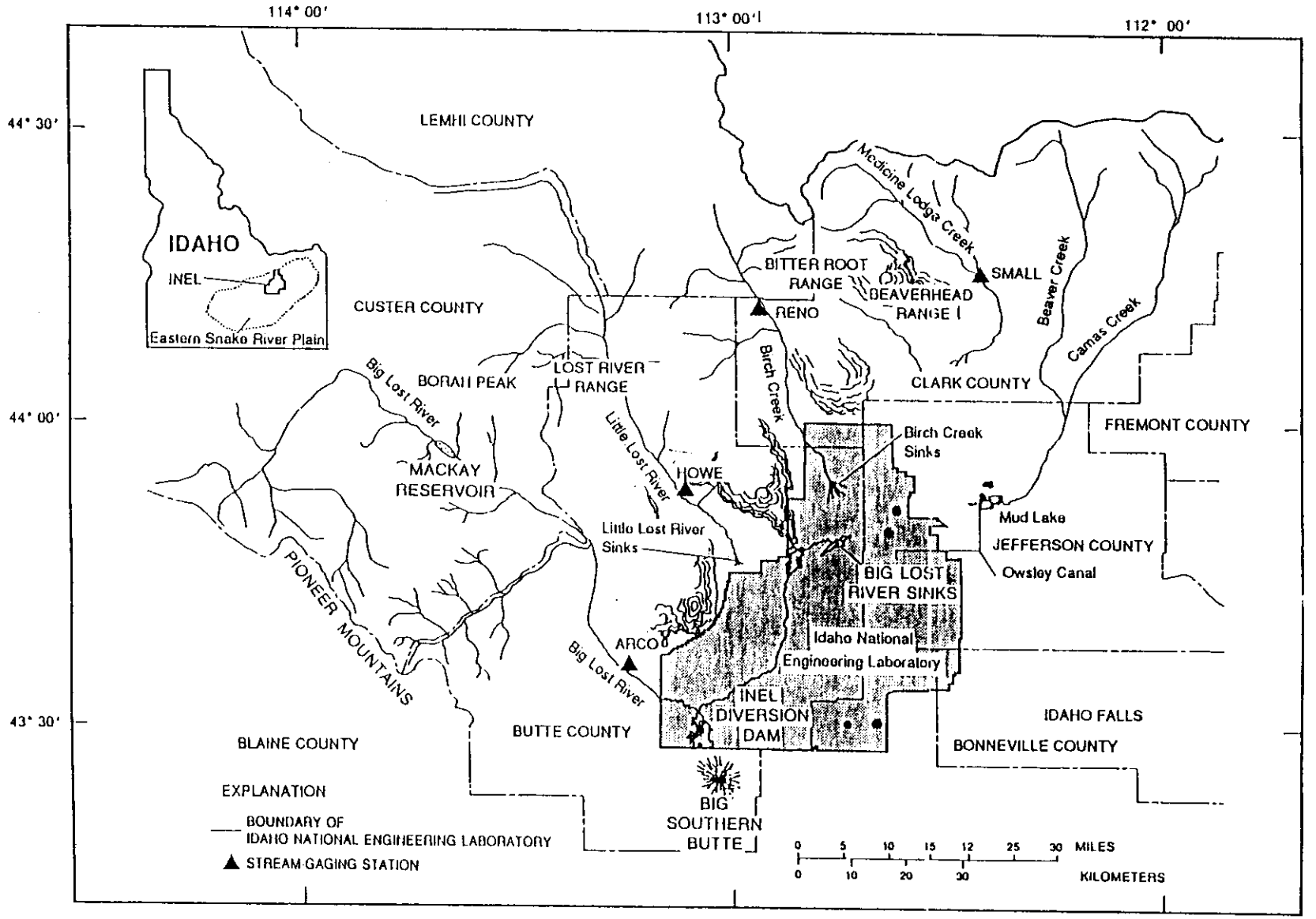


Figure K-2. Location of surface water features on or near the INEEL (Bennett 1990).

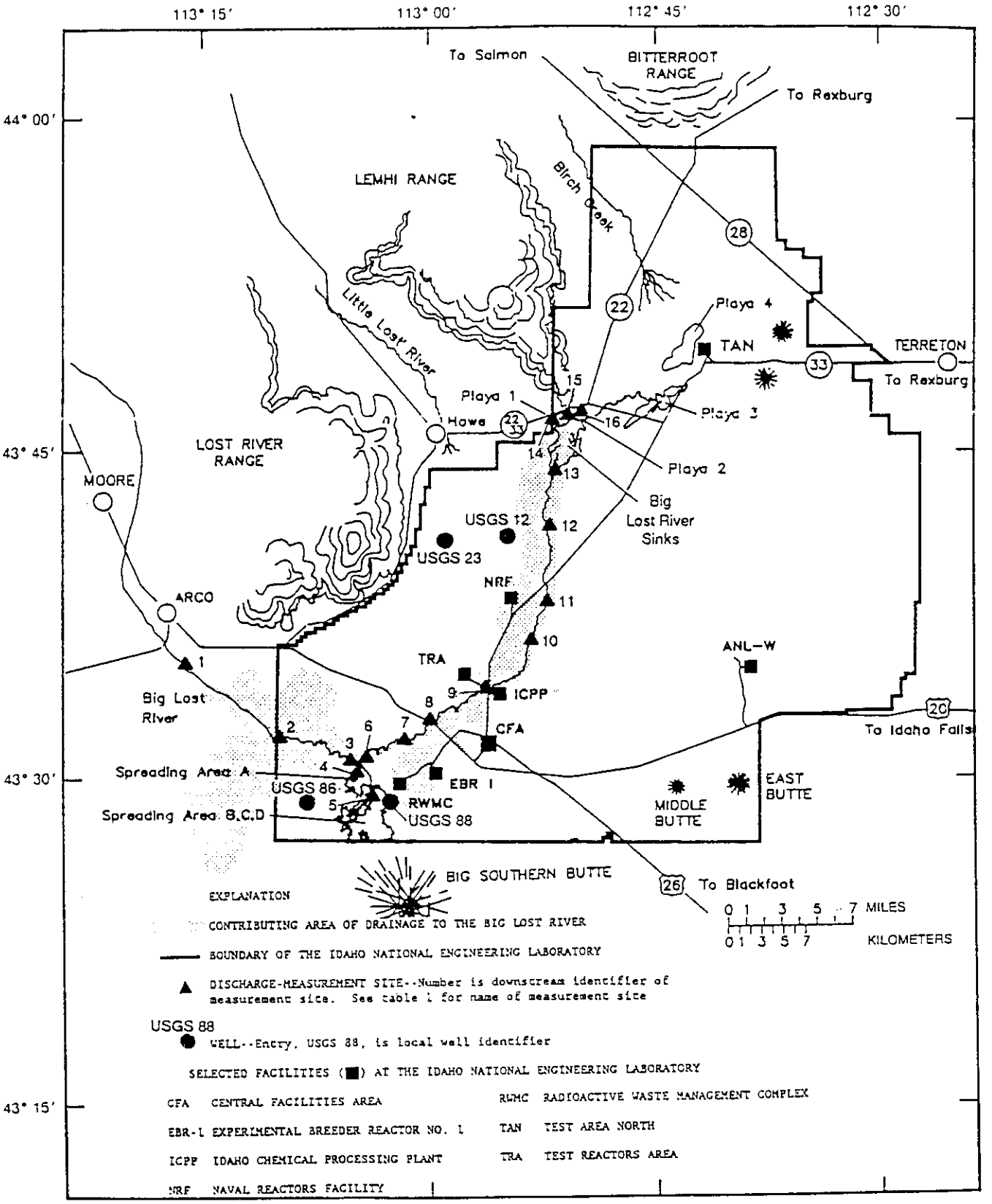


Figure K-3. Location of selected discharge measurement sites, selected wells, and approximate contributing drainage area to the Big Lost River and the INEEL (Bennett 1990).

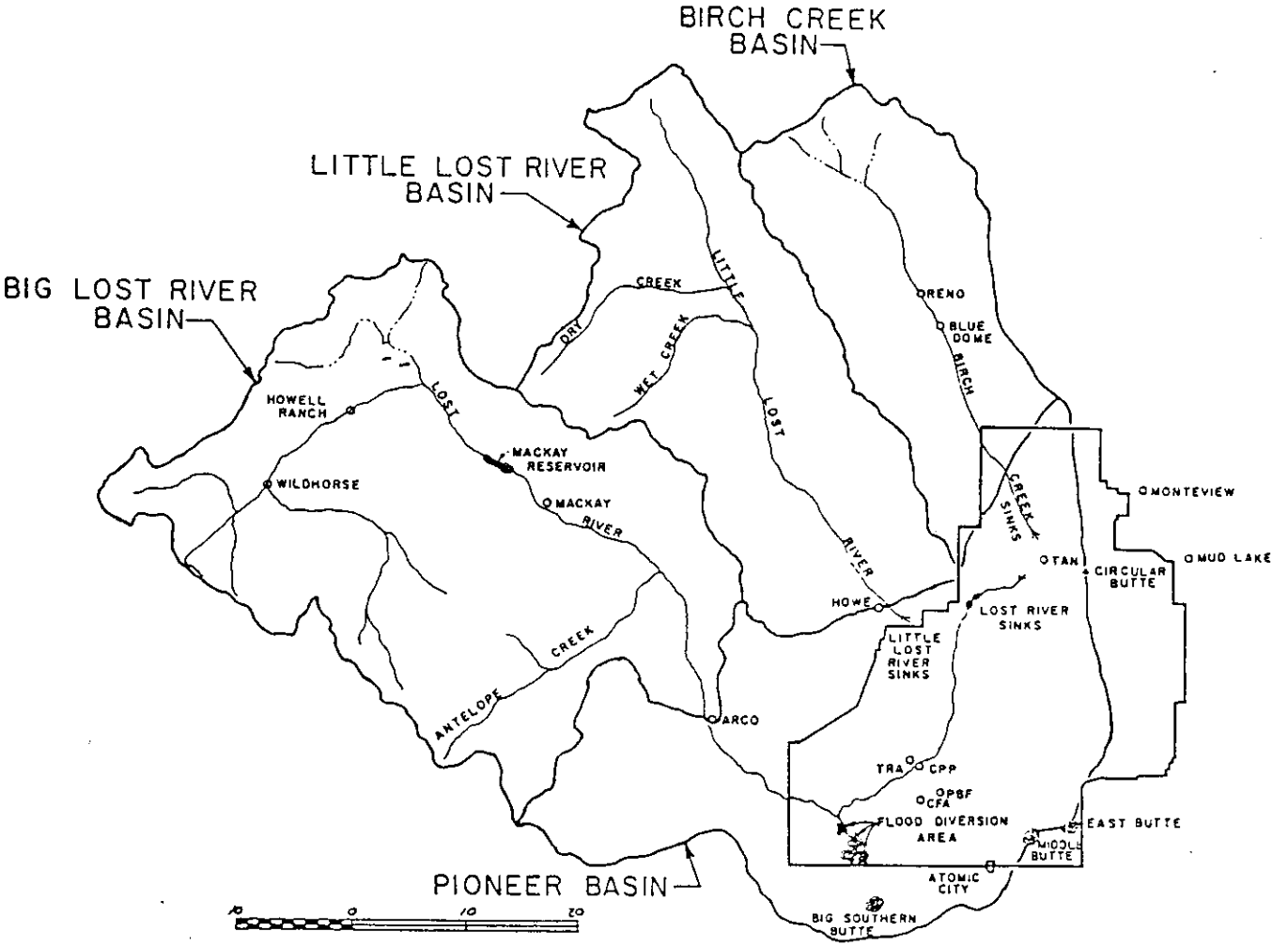


Figure K-4. Drainage basins affecting the INEEL (Niccum 1973).

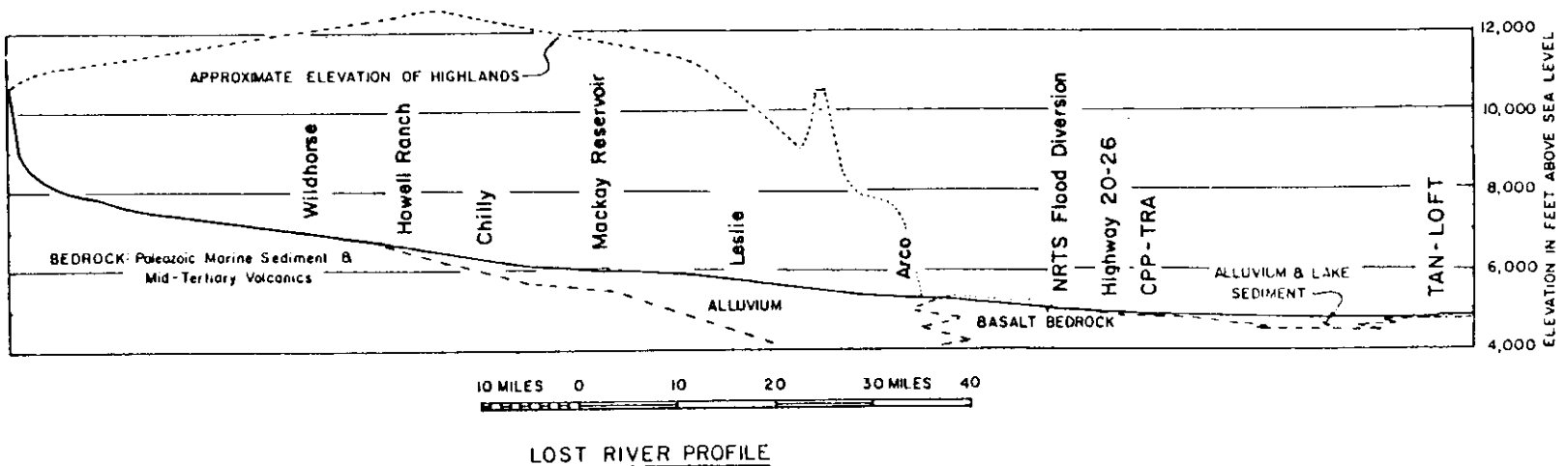


Figure K-5. Big Lost River profile (Niccum 1973).

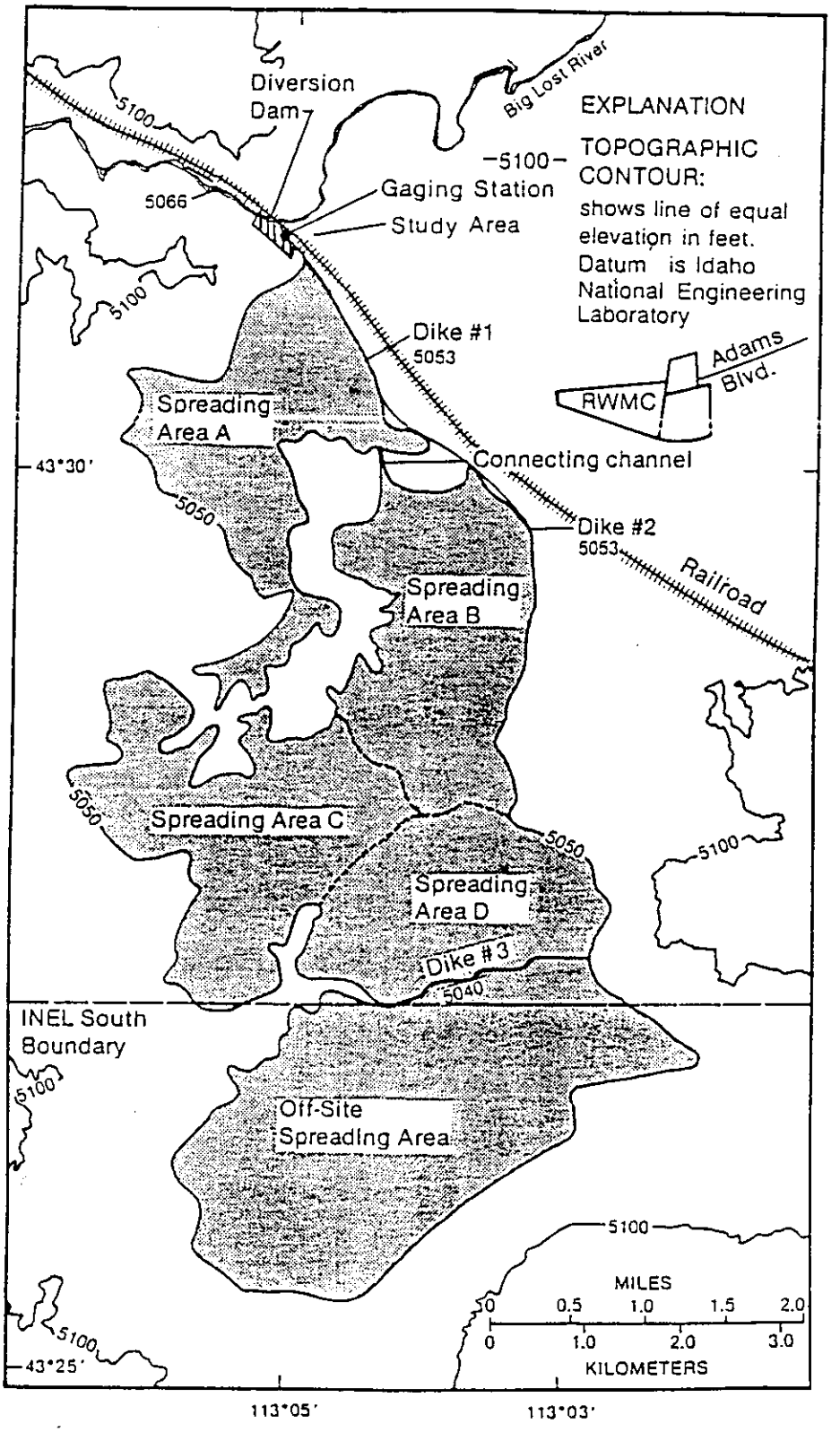


Figure K-6. INEEL Diversion Dam on the Big Lost River and associated Spreading Areas A, B, C, and D (Bennett 1986).

ranges from 1.6 to 6.4 km (1 to 4 mi) in width and is characterized by remnants of old meander channels (Bennett 1990).

As shown in Figure K-5, the channel branches into many small channels upstream from four terminal playas (Playas 1, 2, 3, and 4), and the water spreads across several ponding areas known as the Big Lost River Sinks. Playas 1 and 2 are both located at an elevation of 1,459 m (4,788 ft) msl and have surface areas of about 1.42 and 0.45 km^2 (0.55 and 0.17 mi^2), respectively. Surface areas of Playas 3 and 4 are about 4.1 and 5.5 km^2 (1.6 and 2.1 mi^2), respectively, and both are located at an elevation of 1,457 m (4,780 ft) msl (Bennett 1990).

High water levels that result in ponding or flooding conditions at the INEEL can be caused by the simultaneous occurrence of melting snow and spring rains. Local snowmelt runoff on the INEEL generally occurs in January, February, and March; runoff from the surrounding mountains generally occurs in May or June. The onset of a prolonged freeze usually occurs in late November, lasts 3 months or more and ends in late February or early March. If the ground is frozen when snowmelt occurs, flooding can be extensive because the infiltration capacities of the soils are greatly reduced.

Because of the thickness of the unsaturated zone, streamflow is not affected by regional changes in the SRPA. Infiltration along the stream channel causes most of the differences in discharge between gauging stations on the Big Lost River. Evaporation and transpiration losses are small by comparison. At a flow rate of 8.5 m^3/s (300 ft^3/s), the width of the river is generally less than 18 m (60 ft). At a flow rate of 1.1 m^3/s (40 ft^3/s), the width of the river is less than 9.1 m (30 ft) (Bennett 1990)

Groundwater levels and flow directions in local areas on the INEEL can be temporarily changed by recharge from the Big Lost River. Groundwater mounding can result in areas of significant recharge and can cause local changes in the direction of groundwater flow.

For example, two periods of time, July 1972 to July 1978 and July 1981 to July 1985, demonstrate the relationship between streamflow in the Big Lost River and groundwater levels in the SRPA beneath the INEEL. During the first period, groundwater levels declined; in the second period, groundwater levels increased in elevation. Two local areas on the INEEL had significant groundwater level changes compared to the regional water table: (1) immediately southwest of the Radioactive Waste Management Complex (RWMC), and (2) north of Naval Reactor Facility (NRF). These two areas seem to be significantly affected by recharge from the Big Lost River (Bennett 1990).

A decade (1965 to 1975) of above-normal precipitation and high flow in the Big Lost River, followed by dry years in 1977 and 1978, preceded the net decline in the regional groundwater table for the first period (July 1972 to July 1978). During this period, net groundwater levels declined about 3 m (10 ft) near the RWMC at the INEEL spreading areas and north of the NRF (Bennett 1990).

During the second period (July 1981 to July 1985), a net increase in the regional groundwater table reflected a major change in the volume of recharge from the dry late 1970s to the wet early 1980s. The elevation of the water table rose about 4.9 m (16 ft) in response to recharge from surface water diverted to the spreading areas near the RWMC. The water table also rose about 3.7 m (12 ft) near NRF (Pittman et al. 1988).

The close correlation between perched groundwater levels and streamflow in the Big Lost River is illustrated in Figure K-7. This figure includes the hydrograph of Well 78 and the flow in the Big Lost River near Test Reactor Area (TRA). Well 78 does not penetrate the SRP and is 62 m (203 ft) deep, located 72 m (235 ft) from the river. Changes in streamflow in the Big Lost River cause rapid changes in the perched groundwater levels (Barraclough et al. 1981).

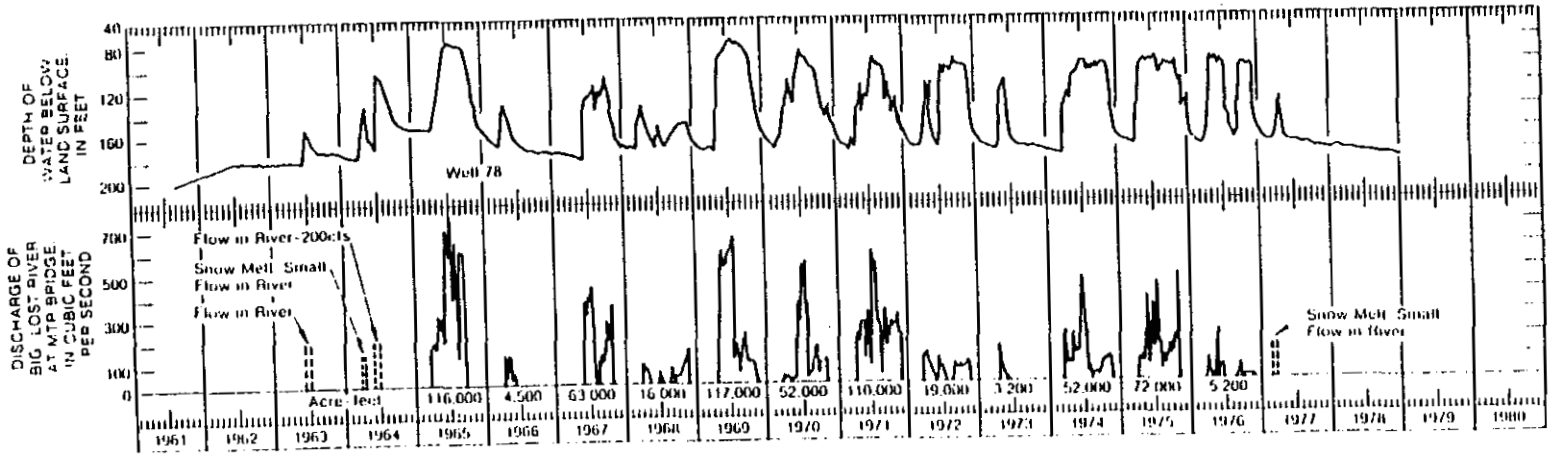


Figure K-7. Correlation between water-level fluctuations in Well 78 and discharge of the Big Lost River at the Lincoln Boulevard Bridge near TRA (Barraclough et al. 1981).

In summary, streamflow in the Big Lost River affects groundwater levels. Both perched groundwater levels and the regional groundwater table of the SRPA at the INEEL varies in response to changes of recharge.

K-2.1.1.2 Birch Creek. The Birch Creek Basin, located about 80 km (50 mi) northwest of Idaho Falls, is an elongated, southeast trending valley. The drainage area of the basin is about 1,943 km^2 (750 mi^2), extending about 64 km (40 mi) in a southeasterly direction. The basin extends from Gilmore Summit to the SRP, where it terminates in the Birch Creek Playa on the INEEL. Test Area North (TAN) is located in the playa. The width of the basin varies from 16 to 29 km (10 to 18 mi). Two mountain ranges flank the basin: (1) Lemhi Range to the west and (2) Beaverhead Mountains to the east. Both mountain ranges rise to elevations about 3,048 m (10,000 ft) msl. Floods are almost nonexistent when the ground is not frozen because the infiltration rate greatly exceeds the snowmelt or rainfall rate. An exception was in the spring of 1969, when frozen ground and an unusual warming trend resulted in extensive snow melt flooding in the lower Birch Creek Valley (Koslow 1984).

Birch Creek is fed by melting snow that infiltrates into the permeable terrain and emerges as springs along existing streambeds. All the surface water runoff in the Birch Creek Basin is either consumed within the basin, recharges the SRPA, or is lost to evaporation. During the summer months, all the Birch Creek streamflow is delivered 4.8 km (3 mi) north of the INEEL to the Reno Ranch, where it is used for irrigation. During the winter, only about half the streamflow (0.34 m^3/s [12 ft^3/s]) is diverted to the Reno Ranch and small power station for stock watering. The natural channel extends south across the INEEL northern boundary and through a culvert under Highway 22 toward the Birch Creek Playa. Birch Creek only flows onto the INEEL during periods of rapid thawing with high rates of runoff; otherwise, the channel is dry (Koslow 1984).

K-2.1.1.3 Little Lost River. The Little Lost River drains the slopes of the Lemhi and Lost River Ranges. Streamflow in the Little Lost River is diverted for irrigation north of Howe. In recent times, surface water flow from the Little Lost River has not reached the INEEL (EG&G 1992). However, the Little Lost River does flow on to the INEEL during high streamflow years, and it then infiltrates into the subsurface (EG&G 1984). For comparison, the average annual discharges for the Big Lost River, Little Lost River, and Birch Creek are listed in Table K-1 (EG&G 1984). Tables K-2 through K-4 list selected physical and chemical water quality measurements made along the Big Lost River, the Little Lost River, and Birch Creek.

Table K-1. Average annual discharge of streams near the INEEL.

Stream	Discharge (m^3/yr [acre-ft/yr])
Birch Creek[a]	70,308,474 (57,000)
Little Lost River[b]	61,674,100 (50,000)
Big Lost River[c]	281,233,896 (228,000)

a. Measured near Reno, Idaho (EG&G 1984).

b. Measured about 11 km (7 mi) northwest of Howe, Idaho (EG&G 1984).

c. Measured below Mackay Dam about 48 km (30 mi) northwest of Arco, Idaho (Bennett 1990).

Table K-2. Water quality measurements along the Big Lost River downstream from Arco through the INEEL 1985.

Sampling Site	Date	Water Temp (°C)	Air Temp (°C)	pH	Specific Conductance (µS/cm)	Chloride (mg/L)	Alkalinity as HCO3 (mg/L)[3]	Discharge (m^3/s [ft^3/sec])
11.9 m (7.4 mi)[b] upstream of the INEEL	May 6	10	25	7.8	323	5	188	10.5 (372)
INEEL western boundary	May 6	12	31	7.9	323	5	185	10.4 (366)
10.5 m (6.5 mi) downstream of boundary	May 6	—	—	—	—	—	—	0.73 (25.7)
10.7 m (6.7 mi) downstream	May 6	12	18	7.9	322	5	183	8.7 (307)
20.6 m (12.8 mi) downstream	May 7	16	21	8.0	323	5	181	8.8 (310)
28 m (17.4 mi) downstream	May 7	15	26	7.9	320	5	188	7.8 (276)
37.3 m (23.2 mi) downstream	May 7	16	20	7.8	318	5	190	47.2 (265)
45.9 m (28.5 mi) downstream	May 7	16	21	7.9	319	5	178	7.3 (257)
49.2 m (30.6 mi) downstream	May 8	12	24	7.8	323	5	—	6.8 (240)
58.1 m (36.1 mi) downstream (above Playa No. 1)	May 8	18	21	8.5	314	5	154	1.4 (50)
Inlet to Playa No. 2	May 8	19	26	8.3	—	—	183	0.99 (35)
62 m (38.5 mi) downstream (below Playa No. 2)	May 8	—	—	—	—	—	—	dry

a. Table taken from Bennett (1990).

b. River miles.

Table K-3. Water quality measurements in the Big Lost River upstream from the INEEL and within the INEEL, Spring and Autumn 1975.

	Spring		Autumn	
Parameter	Upstream from the INEEL	Within the INEEL	Upstream from the INEEL	Within the INEEL
Calcium (mg/L)	42	45	41	34
Magnesium (mg/L)	50	230	10	20
Sodium (mg/L)	5.8	6.6	4.2	5.1
Potassium (mg/L)	1.5	1.5	0.8	1.0
Chloride (mg/L)	4.0	4.0	2.0	2.0
Sulfate (mg/L)	25	21	15.2	17
Fluoride (mg/L)	0.15	0.15	0.1	0.1
Iron (mg/L)	0.19	0.48	0.05	0.48
Nitrate (mg/L as N)	0.45	0.58	1.33	0.55
Total Kjeldahl nitrogen (mg/L)	1.7	1.8	1.4	1.2
Orthophosphate (mg/L)	0.10	0.32	0.02	0.01
Total inoragnic phosphate (mg/L)	0.52	0.37	0.08	0.20
Specific conductivity (µmhos/cm)	280	305	330	310
Alkalinity (mg/L)	140	152	164	152
Total Solids (mg/L)	287	480	254	258

Table K-4. Discharged-weighted mean water quality measurements in the surface water bodies entering the INEEL, 1960–1982.[a]

Parameter	Big Lost River[b] (mg/L)	Little Lost River[b] (mg/L)	Birch Creek[b] (mg/L)
Calcium	35	35	43
Magnesium	9	13	15
Sodium	5.0	7.1	5.6
Potassium	1.3	1.3	1.1
Bicarbonate	140	160	180
Chloride	3.1	7.2	4.7
Sulfate	14	14	29
Silicate	11	13	111
Total dissolved solids	148	169	200

a. Table taken from Wood and Low (1988).

b. Samples collected upstream from the INEEL.

K-2.1.2 Local Drainage

With the exception of the three regional streams described above, only intermittent streams occur on the INEEL with flow occurring for brief periods of time during snowmelt events and rainstorms. Rainfall and snowmelt drain by surface flow into small depressions, where the water infiltrates the soils and may eventually percolate to the SRPA. In some local areas, where soils are frozen or are high in clay content, infiltration decreases. Local flooding can then occur with warm rain or rapid snowmelt. The lack of adequate topographic control and the infrequency with which local flooding occurs, results in local drainage being poorly defined across the INEEL.

Snowfall contributes significantly to the annual precipitation at the INEEL. The average annual snowfall at the INEEL is 70 cm (27.6 in.) and the maximum annual recorded snowfall is 152 cm (59.7 in.). An average of 16 cm (6.4 in.) falls in December, the month of maximum snowfall. The maximum monthly snowfall on record is 46 cm (18.1 in.) (Clawson et al. 1989). About 30% of the average annual precipitation (22 cm [8.71 in.]) at the INEEL results from the water content in snow. However, the dry air and cold winter temperatures reduce the potential moisture content of the snow (EG&G 1992).

Ponding or flooding conditions can occur at the INEEL coincident with melting snow, spring rains, and warm winds. If the ground is frozen when these conditions occur, flooding can be extensive because of the reduction in infiltration capacity of the soil. Local runoff from rapid spring thaws has resulted in flooding of the RWMC at least three time in past years (1962, 1969, and 1982). Similar local snowmelt flooding also occurred at TAN in 1969 (Koslow and Van Haaften 1986).

A frequency analysis of local basin snowmelt for several facilities at the INEEL was conducted in 1986 using historical data. Precipitation data from the Central Facilities Area (CFA) weather station for the period from 1956 to 1985 were used in the analysis. These data were assumed to be representative of precipitation across the INEEL (Koslow and Van Haaften 1986).

The combined rain and snowmelt that would be expected to occur once every 25 years was estimated to be 7 cm/day (2.74 in./day). A cumulative design rainfall of 2 cm/day (0.78 in./day) results in 1.3 cm/day (0.52 in./day) of direct runoff. Because the areal extent of snow cover varies considerably with topographic features, snow depth was assumed to be at least 12.7 cm (5 in.) and to cover 50% of the total drainage area for each facility. Peak flow rates resulting from this combined rain and snowmelt were 0.93, 0.91, 1.8, and 0.99 m^3/s (33, 32, 63, and 35 ft^3/s) for the CFA, Idaho Nuclear Technology and Engineering Center (INTEC)—formerly the Idaho Chemical Processing Plant (INTEC), TRA, and NRF, respectively (Koslow and Van Haaftlen 1986).

More recent investigations by Sagendorf (1991) and Zukauskas et al. (1992) for a design analysis conducted by used meteorological data from CFA for the period 1950 through 1990 and determined estimates for the 25- and 100-year return periods for the maximum 24-hour precipitation amounts and for the 25- and 100-year maximum snow depths at the RWMC. For the winter months, mid-November through mid-March, when a rain-on snow event is likely to occur and the ground is frozen, the 25- and 100-year, 24-hour duration amounts were found to be 3.5 and 4.2 cm (1.36 and 1.64 in.), respectively. The expected 25-year maximum snow depth was determined to be 57 cm (22.6 in.), and the 100-year maximum snow depth was found to be 78 cm (30.6 in.). The peak discharges for the 25- and 100-year rainfall-on-snowmelt floods for the RWMC watershed were estimated by Zukauskas et al. (1992) to be 18 and 20 m^3/s (643 and 704 ft^3/s), respectively.

K-2.1.3 Regional Groundwater Hydrogeology

The INEEL is located on the western edge of the ESRP, which overlies the largest potable aquifer in Idaho. The SRPA is defined as the continuous body of groundwater underlying nearly all of the ESRP. The water table map of the SRPA (Figure K-8) shows that groundwater flow is primarily in a southwest direction, although locally the flow direction can be affected by recharge from rivers, surface water spreading areas, and heterogeneities in the aquifer. Aquifer boundaries correspond to surface physical features (i.e., mountains on the west and north and the Snake River on the east). The SRPA is approximately 322 km (200 mi) long, 65 to 95 km (40 to 60 mi) wide, and covers an area of approximately 25,000 km^2 (9,600 mi^2). It extends from Hagerman, Idaho, on the west to near Ashton, Idaho, northeast of the INEEL. The EPA Region 10 designated the SRPA a sole source aquifer under the Safe Drinking Water Act on October 7, 1991 (56 Federal Register [FR] 50634).

Occurrence and movement of groundwater in the aquifer are dependent on both the geologic framework, which determines aquifer transmissivity and storage, and the recharge and discharge within that framework. The aquifer is comprised of numerous relatively thin basalt flows extending to depths in excess of 1,067 m (3,500 ft) below land surface (bls). Over time, some of these flows have been exposed at the surface long enough to collect sediment and develop soil horizons. These sedimentary horizons are known today as sedimentary interbeds, which are found sandwiched between basalt flows at various depths. Regionally, most water moves horizontally through basalt interflow zones, which are the broken and rubble zones between lava flows. Locally, water moves vertically along joints and the interfingering edges of interflow zones, and sedimentary interbeds act to restrict the vertical movement of groundwater (Garabedian 1986).

A general description of the water-transmitting properties of basalt flows helps explain the wide range of measured aquifer parameters. To a large extent, structural and textural characteristics of individual flows within flow groups control the movement of groundwater through the SRPA. Vesicular, highly fractured flow tops and fractured flow bases combine to form what is generally the most permeable part of the aquifer, unless fractures near this interface are filled with sediment. The dense, massive central portion of a flow can have a very low permeability. The thickness and extent of these flow features is known to vary widely over relatively short distances in the Snake River basalts, and departure from the idealized case is common (Mundorff et al. 1964).

Sedimentary interbeds also have a significant impact on aquifer properties. Clay-rich interbeds impede groundwater movement, although coarse-grained interbeds may be more permeable than some basalts. In general, sedimentary interbeds have lower hydraulic conductivity than the surrounding basalts. There is uncertainty associated with the correlation of permeable zones in basalts and sedimentary interbeds resulting from the natural lack of continuity between flows, the cooling processes that caused wide variations in the basalt structure, and differential sedimentation that occurred during periods of volcanic quiescence. However, at sufficiently large scales of integration the heterogeneties of the basalt and sediments are combined to such an extent that an equivalent porous media approach can approximate groundwater movement. Garabedian (1986) used a computer program to simulate two-dimensional, steady state groundwater flow in the SRPA. At the regional scale, modeling of the aquifer showed a strong correlation to observed water level measurements, indicating that flow at a large scale is relatively well understood.

Younger basalts (Quaternary) in the aquifer generally yield large quantities of water to wells. Where interflow zones include sediments and secondary minerals, transmissivity is decreased. Generally, older basalts (Tertiary) yield less water than younger basalts as a result of secondary minerals filling vesicles, fractures, and interflow rubble zones. Aquifer thickness is largely unknown, but geophysical studies suggest that locally the Quaternary basalt aquifer may be several hundred meters (thousand feet)

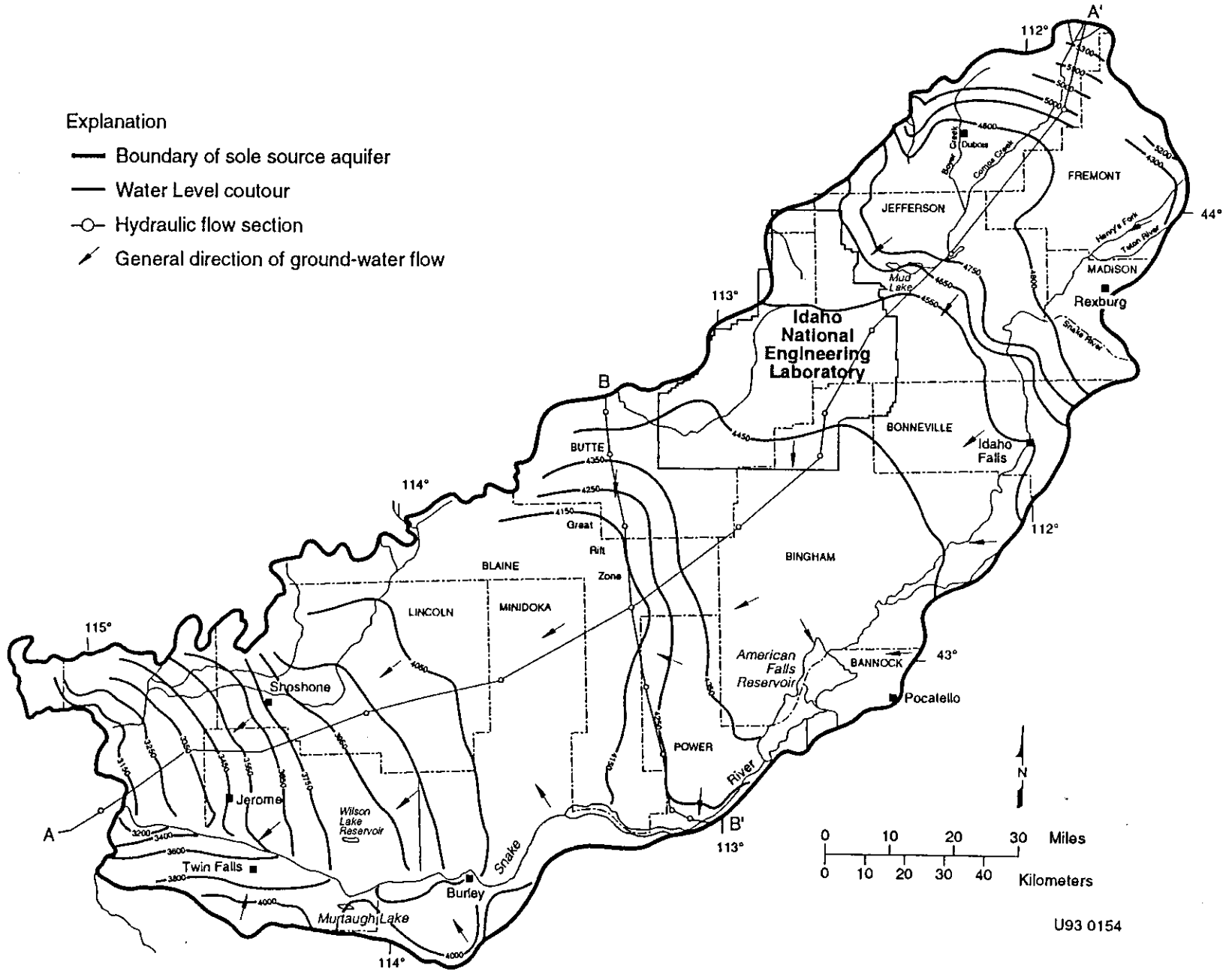


Figure K-8. Water table elevations of the SRPA and general direction of ground water flow, spring 1980 (Lindholm et al. 1986).

thick (Whitehead 1986). It is generally believed that the upper several tens of meters (hundred feet) of the aquifer are the most transmissive because porosity and hydraulic conductivity appear to decrease with depth. Most water moves through the highly conductive upper 61 to 152 m (200 to 500 ft) of the Quaternary basalt. Miocene basaltic and rhyolitic rocks with lower hydraulic conductivity underlie the Quaternary basalt. Even though sand and gravel deposits several tens of meters (hundred feet) thick can transmit large volumes of water along the margins of the plain, it is still significantly less water than the basaltic portion of the aquifer.

The distribution of sediment and basalt within the ESRP has a significant impact on the ability of the aquifer to transmit and store water. Figure K-9 and K-10 show the thickness of basalt and sedimentary rocks, respectively, for the ESRP. Figure K-10 clearly shows the deposition of sedimentary rocks along the course of the Snake River and the Big Lost River. Additionally, the boundary between the Quaternary and Tertiary volcanics and the older limestones and shales, which form the surrounding mountains, can be seen. Figure K-10 shows the lack of sedimentary cover in the center of the plain, which is of hydrologic interest. The exposed basalt is very permeable and allows water to easily enter the ground and recharge the aquifer.

In areas of thick, clean basalt, the transmissivity of the aquifer is extremely high (Figure K-9). The transmissivity of the aquifer is considerably less where sediments predominate. Transmissivity of the aquifer has strong implications on groundwater flow and the hydraulic gradient. In areas with relatively lower transmissivity the hydraulic gradient is generally steeper than in areas of basalt with high transmissivity. Volcanic rift zones are also thought to impede groundwater flow by means of vertical dike swarms that crosscut the horizontally transmissive basalt flows. Also, as discussed earlier, sedimentary interbeds and sedimentary infilling of fractures and interflow zones can reduce aquifer transmissivity.

The water table map of the SRPA (Figure K-8) shows that groundwater flow is primarily in a southwest direction, although locally, the flow direction can be affected by recharge from rivers, surface water spreading areas, and heterogeneities in the aquifer. Large variations in the hydraulic gradient can be observed (Figure K-8). By comparing Figure K-8 to Figures K-9 and K-10, the cause of the steep gradients in the center and at the southwest and northwest end of the aquifer can be identified. The steep gradient near the center of the plain correlates to the Great Rift Zone and is likely caused by vertical dikes that limit the aquifer's ability to transmit water. The thinning of the basalts and an increase in sediments causes the steep gradient to the southwest. Similarly, the steep gradient near Jefferson County and Mud Lake is probably caused by the increase in sediments in that area deposited in ancient Lake Terreton.

Transmissivity of Quaternary basalt, as determined from aquifer tests, ranges from 93 to 9,300 m^2/day (1,000 to 100,000 ft^2/day) and, in places, exceeds 93,000 m^2/day (1 million ft^2/day) (Whitehead 1992). Garabedian (1986) obtained similar but generally higher values (up to 353,000 m^2/day [3.8 million ft^2/day]) through regional best fit modeling of the aquifer. Transmissivity values obtained from aquifer tests are generally lower than those determined from modeling because wells tested were partially penetrating, whereas modeled transmissivities used to the entire saturated thickness.

Yields of wells completed in the Snake River basalts are among the largest in the nation. Irrigation wells open to less that 30.5 m (100 ft) of the aquifer yield as much as 26,498 L/min (7,000 gal/min) with about 1 m (3 ft) of drawdown; yields of 7,571 to 11,356 L/min (2,000 to 3,000 gal/min) are common. However, because of the heterogeneity of basalt, not all wells are as successful. Well yields may be lower in areas of thick flows and dense basalt.

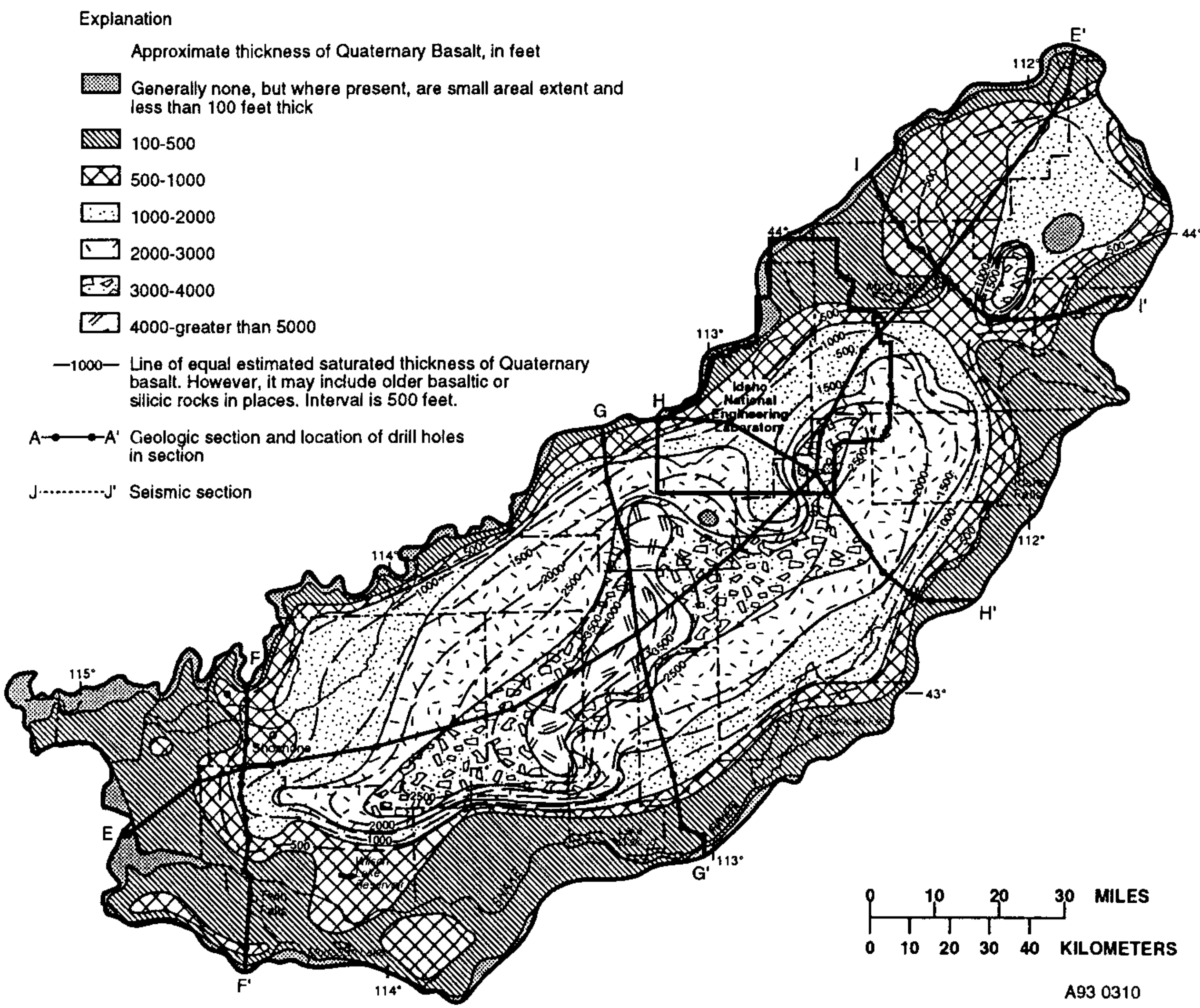


Figure K- 9. Thickness of quaternary basalt (ft) (Whitehead 1986).

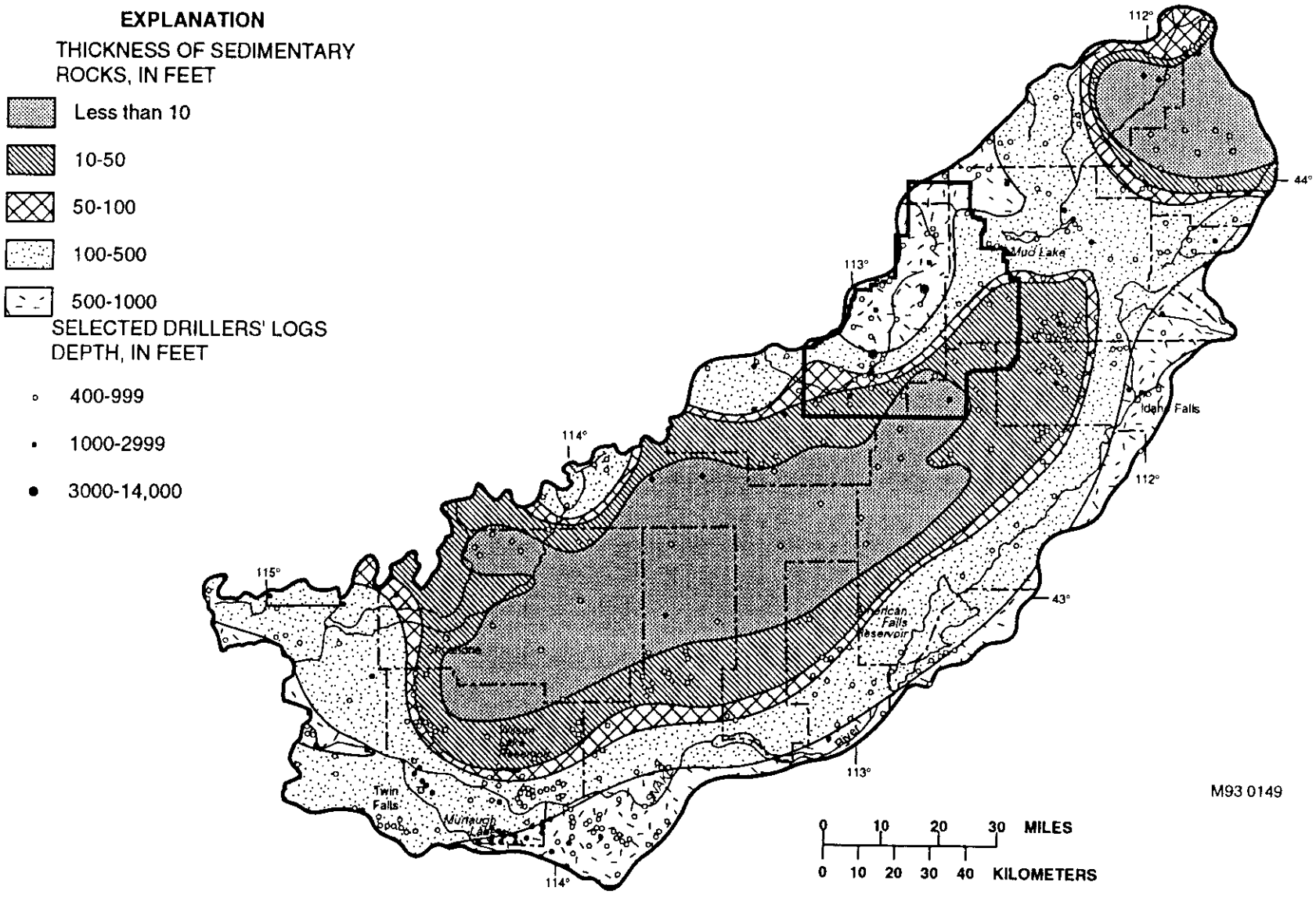


Figure K- 10. Thickness of sediments (ft) (Whitehead 1986).

Storage coefficients determined from aquifer tests vary widely. Values range from 1E-05 to 1E-01, indicating that aquifer conditions range from confined to unconfined (Whitehead 1992). Because of the heterogeneity of basalt and intercalated sedimentary rocks, groundwater is confined in places, as is suggested by low storage coefficients. As a whole, the aquifer behaves as an unconfined system, but clay layers and dense-unfractured basalt are locally confining.

Water storage in the SRPA has been estimated at 3.1E+12 m^3 (2E+09 acre-ft), which is about the same volume of water stored in Lake Erie or enough water to cover the entire state of Idaho to a depth of 1.2 m (4 ft). Approximately 6.2E+11 m^3 (5E+08 acre-ft) of the water stored in the aquifer could potentially be removed by pumping (Robertson et al. 1974).

Recharge to the SRPA is from seepage of irrigation water, stream flow and canal leakage, tributary valley underflow, and direct precipitation. Aquifer discharge is largely spring flow to the Snake River and irrigation withdrawals. Major springs are near American Falls Reservoir and along the Snake River from Milner Dam to King Hill. About two-thirds of the groundwater discharged from the aquifer is through the series of springs between Milner and King Hill. Included in that reach are 11 of the 65 springs in the United States that discharge an average of more than 2.8 m^3/sec (100 ft^3/sec) (Meinzer 1927).

Regional comparisons of water levels indicate that water levels have been relatively stable in the central part of the ESRP for the last 50 years (Garabedian 1986). However, on large tracts of land in the eastern plain, water levels rose an average of 18 and 21 m (60 and 70 ft) (Mundorff et al. 1964), and groundwater discharge increased soon after the initiation of surface water irrigation in 1910. By 1928, most surface water for irrigation was appropriated. Since that time, the total amount of water diverted for irrigation has been relatively stable. The result has been a small, but definite decline of groundwater levels and decrease in groundwater discharge (Figures K-11 and K-12). The decrease probably results from a combination of factors including an increase in withdrawals of groundwater, decrease in diversions of surface water, increase in efficiency of irrigation (largely the use of sprinklers), and climatological changes (Lindholm 1981).

Garabedian (1986) calculated the water budget for the SRPA in 1980 (Table K-5). A net loss in groundwater storage of about 1.6E+07 m^3 (130,000 acre-ft) was estimated from water-level changes measured in 1980. Storage coefficients used for the estimates are 0.05 for basalt, determined from pumping test data (Mundorff et al. 1964), and 0.20 for sediments.

Based on the Garabedian model, if the 1980 conditions of recharge and discharge are extended to the year 2010, the model indicates that water levels may decline 0.6 to 2.4 m (2 to 8 ft) in most of the ESRP with greater declines along the boundaries. Spring flow may decrease about 5% and river leakage into the aquifer may increase 9%. As an extreme example, if groundwater withdrawals were increased by 68 m^3/sec (2,400 ft^3/sec) in order to irrigate another 4,047 km^2 (1 million acres) in the ESRP, head declines of 3 to 15 m (10 to 50 ft) and a decrease in spring flow of 20% might be expected within 30 years.

K-2.1.4 INEEL Hydrological Conditions

Hydrogeologic conditions at the INEEL have been the subject of investigation by the USGS and U.S. Department of Energy (DOE) contractors and consultants for over 40 years. These efforts have provided a basic foundation for understanding groundwater flow in the SRPA.

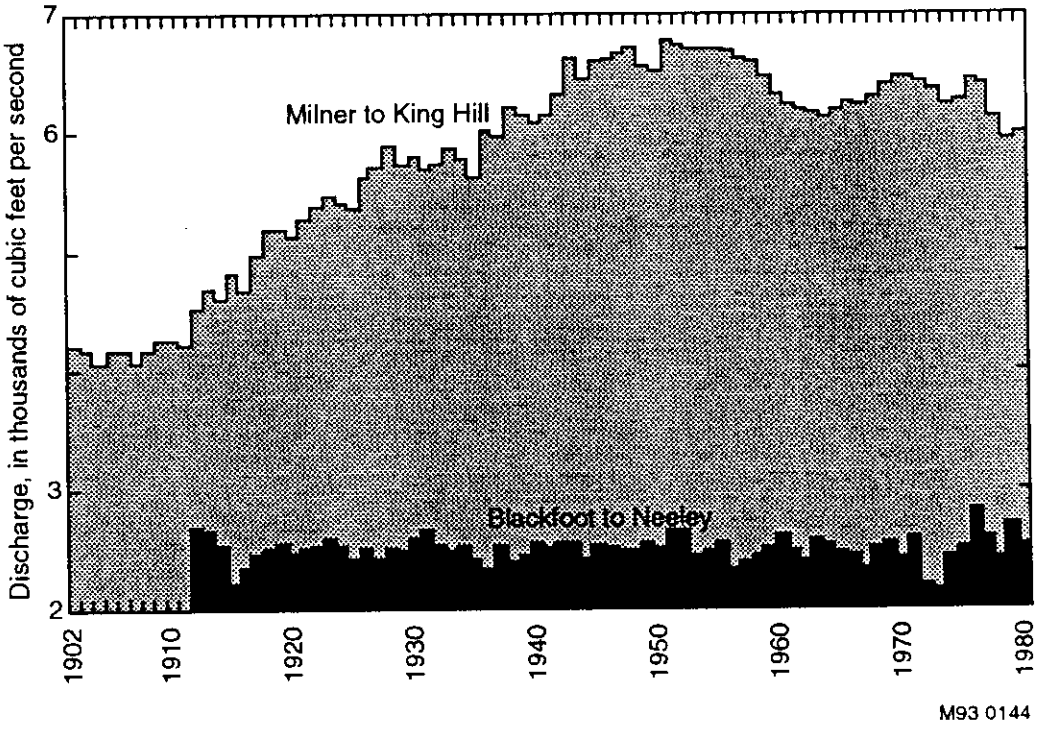


Figure K-11. Spring discharge from 1902 to 1980 along the Snake River (2.5 m^3/sec [80 ft^3/sec]) (Kjelstrom 1986).

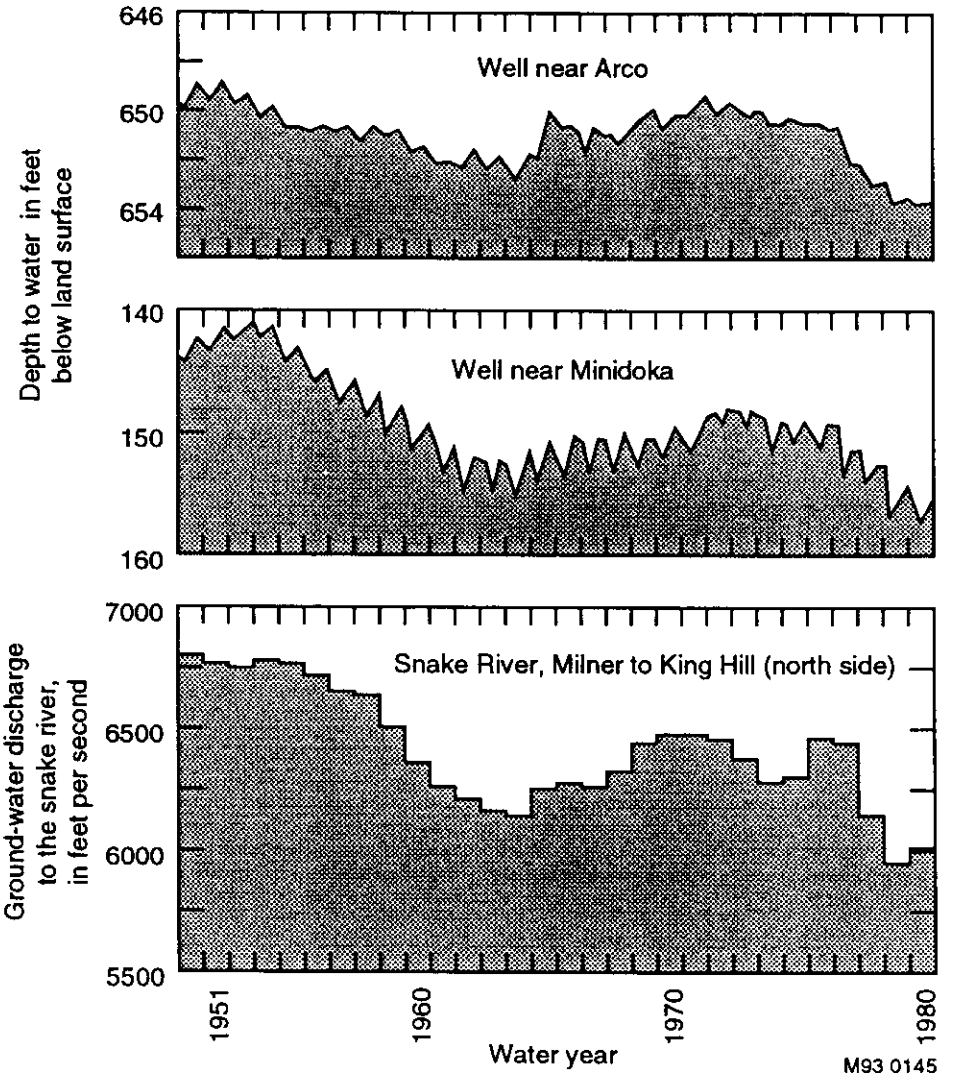


Figure K-12. Relation of ground water levels to ground water discharge from the SRPA (Lindholm 1981).

Table K-5. Aquifer budget for water year 1980.[a]

Sources		Recharge (acre-ft)
Surface water irrigation		5,095,500
Snake River loss		880,500
Tributary stream and canal losses		491,800
Precipitation		1,226,700
		763,200
	Total	8,457,700
		Discharge (acre-ft)
Springs discharging to Snake River		7,275,300
Groundwater pumpage		1,641,300
	Total	8,916,600
	Change in Storage	-127,300

a. Source: Garabedian (1986).

b. Differences in estimates = $\frac{-331,600}{8,916,600}$ = -0.04
discharge

The USGS conducts a Site-wide groundwater monitoring program at the INEEL to determine effects of INEEL operations on groundwater quality and quantity. The basis for this program goes back to 1949, when the U.S. Atomic Energy Commission requested that the USGS investigate and describe the water resources of the INEEL and adjacent areas. Information was collected that depicted hydrogeologic conditions before reactor operations began. Since that time, the USGS has maintained a groundwater monitoring system and conducted investigations to determine changes in water quality and quantity resulting from activities at the various facilities at the INEEL. Periodic summaries have been published including those by Nace et al. (1959), Barraclough et al. (1965, 1966, 1976, 1981), Robertson et al. (1974), Barraclough and Jensen (1976), Lewis and Jensen (1984), Pittman et al. (1988), and Orr and Cecil (1991). Well logs, water levels, and water chemistry data are available in files at the INEEL office of the USGS.

K-2.1.4.1 Wells. Groundwater monitoring networks used by the USGS consist of a series of wells from which water level and water-quality data are systematically collected. The INEEL water-level monitoring network provides data for observing changes in the hydraulic gradients within the SRPA. Changes in the hydraulic gradient will affect the rate and direction of groundwater movement; and therefore, groundwater contaminant movement. Observed water levels provided by the INEEL water-level monitoring network also allow for identifying groundwater recharge zones and studying the effects of recharge. The USGS routinely monitors water levels in 160 on-Site wells and boreholes (i.e., 120 in the aquifer and 36 in perched water zones).

Approximately 140 wells and boreholes (i.e., 99 in the aquifer and 38 in perched water zones) are monitored for water quality on or near the INEEL. The USGS conducts a comprehensive aquifer-well sampling program to identify contaminants and observe contaminant migration within the SRPA. Sampling of perched water wells and surface water sites is performed to provide data on the quality of water that is recharging the aquifer.

K-2.1.5 WAG 6 Groundwater Hydrology

Data on hydrologic parameters in the WAG 6 area were generated by an aquifer test conducted at well EBR-I in 1949 (Wood 1989). The discharge rate was held at 50 L/s (800 gpm) during the test. The well is open to the aquifer through a saturated thickness of 145 m (475 ft). The maximum drawdown during the test was 5 m (17 ft), which, taken together with the 145-m (800-gpm) discharge rate, yields a specific capacity of 840 m^3/d/m (47 gpm/ft). Transmissivity was estimated at 446 m^2/day (4,800 ft^2/d). No estimate for storativity specific to WAG 6 area is available. Storage coefficients in the SRPA at INEEL are generally considered to fall in a range from 0.01 to 0.06.

The water level at BORAX is approximately 180 m (595 ft) bls (Orr and Cecil 1991). The general direction of groundwater flow in the area is to the southwest.

K-2.1.5.1 Recharge. No liquid waste is presently discharged to the SRPA or land disposal ponds at WAG 6. Water is withdrawn from well EBR-I only to meet the limited water-supply requirements of the EBR-I historical monument, which is closed during the winter months.

No natural streams or rivers recharge the SRPA near WAG 6. The only form of recharge that occurs there is infiltration from precipitation. Based on meteorological data from CFA, precipitation at WAG 6 averages approximately 22 cm/yr (8.5 in./yr). Evaporation rates are high during much of the year, with the result that minimal recharge normally takes place. Recharge rates may be somewhat higher during the spring snowmelt season when moderate temperatures minimize evaporation, but large quantities of surface-water recharge generally are not expected in the WAG 6 area.

K-2.1.5.2 Perched Water. Because the unsaturated zone in the vicinity of WAG 6 has been penetrated by only one well, no bodies of perched water are known in the area. However, lack of large quantities of recharge from either man-made or natural sources makes it unlikely that perched water exists here.

K-2.1.5.3 Groundwater Hydrology of the Liquid Corrosive Chemical Disposal Area. Groundwater beneath the Liquid Corrosive Chemical Disposal Area (LCCDA) occurs at a depth of about 177 m (580 ft) below ground surface. The hydraulic conductivity of the SRPA in the area of the LCCDA is on the order of 213 m/day (700 ft/day) (Robertson 1974). During calibration of a computer model of contaminant transport in the SRPA at the INEEL, the effective porosity of the aquifer was determined to be about 10% (Robertson 1974). The rate and direction of groundwater flow at the LCCDA is complicated by the presence of large infiltration basins, the spreading areas for the Big Lost River west of the RWMC. In normal and dry years, the direction of groundwater flow is south-southwest with a gradient of 3 to 6 ft/mi (Wood 1989). During wet years with recharge from spreading areas, the direction of flow shifts to the east, and the general direction of flow at the LCCDA shifts to the southeast. Very high gradients develop under the spreading areas, as much as 13 ft/mi (Wood 1989), but they do not seem to reach as far east as the LCCDA. Based on a permeability of 700 ft/day, a porosity of 10%, and a range in hydraulic gradient of between 3 and 6 ft/mi, the range of groundwater velocities should be between 0.91 and 1.8 m/day (4 and 8 ft/day) (Hull et al. 1994).

K-2.1.5.4 Groundwater Hydrology of the Organic-Moderator Reactor Experiment. The SRPA in the vicinity of the Security Training Facility (STF) consists of a series of saturated basalt flows and interbeds. The water level in the OMRE production well was approximately 152 m (497 ft) belowground when the well was drilled in 1956. The initial water level measured in the Experimental Organic-Cooled Reactor (EOCR) production well was approximately 148 m (484 ft) belowground when that well was drilled in 1960. Water levels are not routinely measured in the Organic-Moderated Reactor Experiment (OMRE) and EOCR production wells, but water level contours constructed from surrounding wells in the region indicate that the direction of flow at the STF is generally to the south (Orr and Cecil 1991).

K-2.1.6 WAG 10 (INEEL) Groundwater Hydrology

Depths to the water table from the INEEL land surface range from about 61 m (200 ft) in the northern part of the site to more than 274 m (900 ft) in the southern part (Pittman et al. 1988). The SRPA generally behaves as an unconfined aquifer. However, in some places and at a local scale it behaves as though it were confined (Nace et al. 1959).

The vertical dimension of the aquifer is an important, but poorly determined geometric element, which is primarily controlled by geologic features. Drilling information indicates that at least 610 m (2,000 ft), and in places, over 1,524 m (5,000 ft), of basalt underlie the INEEL. However, not all of this thickness is part of the active flow system. Based on hydrologic and geologic data, the effective aquifer base is considered to coincide with the top of a thick, widespread sequence of clay, silt, sand, and basalt that occurs at depths ranging from 244 to 457 m (800 to 1,500 ft) bls (see Figure K-13) (Mann 1986; Anderson 1990, 1991). The effective thickness of the aquifer beneath the INEEL varies with different areas, and a distinct boundary between the different areas is not well defined at this time.

Ackerman (1991) analyzed aquifer test data of 183 single-well tests at 94 wells in the SRPA to estimate values of transmissivity. These data were obtained in a consistent manner and are useful for describing the distribution of transmissivity at the INEEL. Estimates of transmissivity for individual wells ranged from 0.1 to 70,606 m^2/day (1.1 to 7.6×10^5 ft^2/day), nearly 6 orders of magnitude. The calculated values presented by Ackerman represent the transmissivity near the test wells and within the test interval. Because of the high degree of heterogeneity of the basalt and the unknown thickness of the aquifer, it is likely that the transmissivity of the whole basalt sequence is higher because the effects of partial penetration decrease transmissivity calculated from pumping tests. Earlier studies performed on 20 different production and test wells presented transmissivities ranging from 372 to 2.2×10^5 m^2/day (4,000 to 2.4×10^6 ft^2/day) (Walker 1960; Walton 1958). Lowest values are generally at the northern end of the site and the highest values are near the TRA.

In an effort to estimate the hydraulic conductivity of the aquifer beneath the INEEL, the transmissivity values estimated by Ackerman (1991) were normalized by dividing the transmissivity value by the length of the open interval of test well, which is typical for short-term pumping tests. A plot of the number of tests (frequency) versus the log of the computed hydraulic conductivity is presented in Figure K-14. It shows hydraulic conductivity ranges from 0.0003 to 30.4 m/day (0.001 to 1,000 ft/day) with the highest frequency around 30.5 m/day (100 ft/day).

The actual flow zones may be shorter than the saturated open interval of the wells. Actual hydraulic conductivities could be higher than hydraulic conductivities presented in this chapter. Figure K-14 shows a plot of hydraulic conductivity (normalized) versus depth below the top of the aquifer. This plot clearly demonstrates that the most transmissive portion of the aquifer is the upper 76 m (250 ft). These observations confirm the studies of Robertson et al., (1974), Mann (1986), and Anderson (1990, 1991) suggesting that the effective base of the aquifer does not extend to the base of the basalt sequence.

Multiple well aquifer tests are necessary to estimate aquifer storage. There have been few multiple-well aquifer tests conducted at the INEEL. Values of total aquifer storage capacity that have been measured at the INEEL range from 0.01 to 0.06 (Arnett and Lee 1991), which is indicative of unconfined conditions.

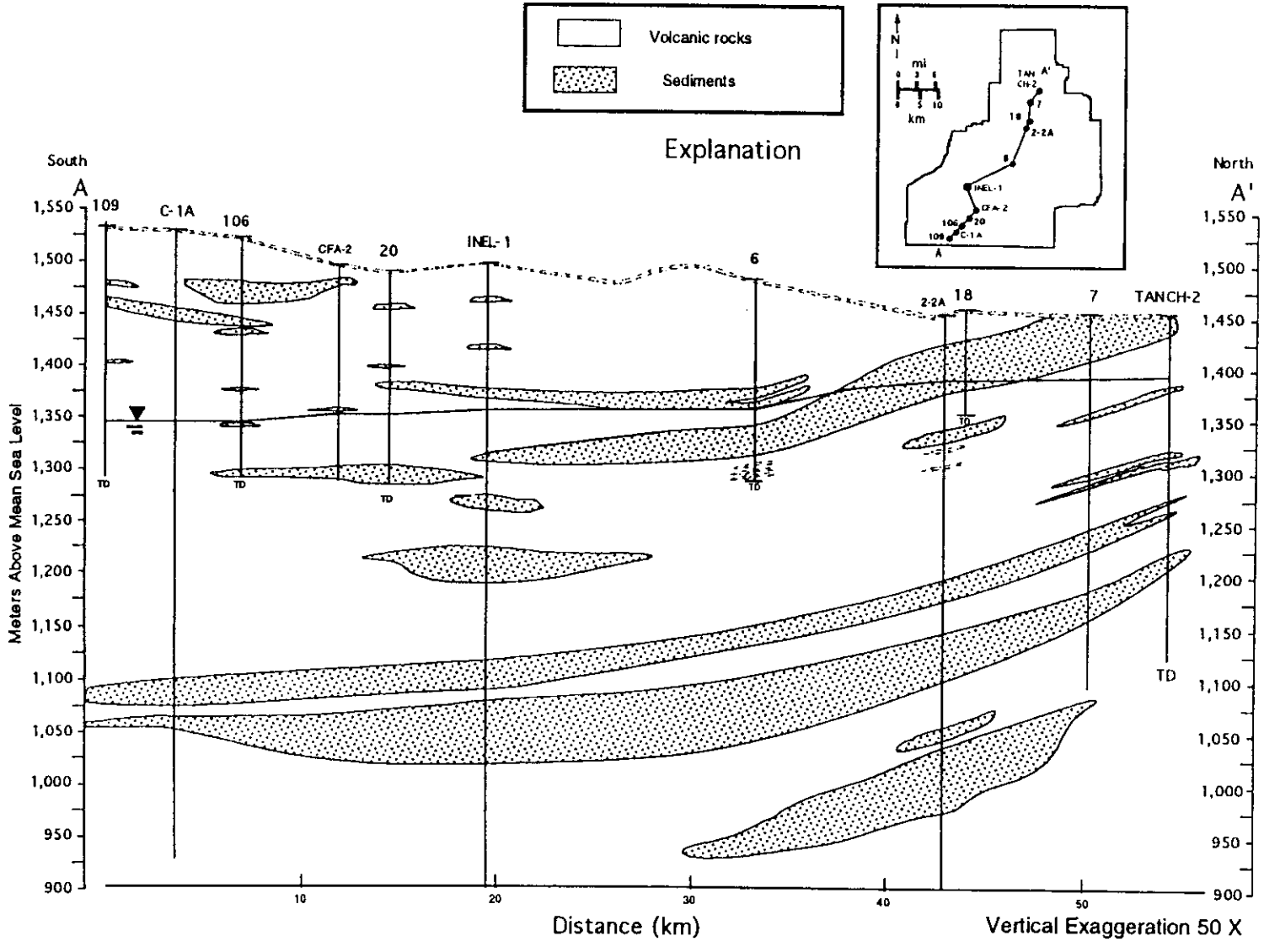


Figure K-13. Regional cross-section through the INEEL.

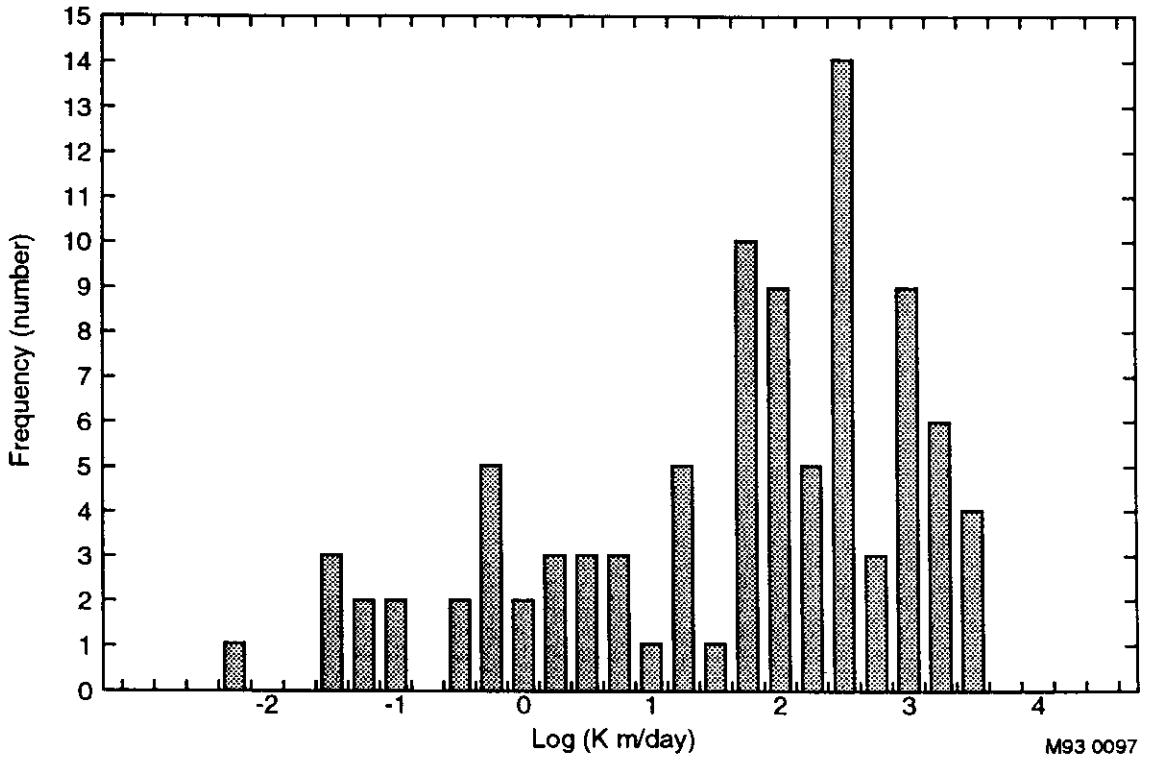


Figure K-14. Relationship of the number of pumping tests to hydraulic conductivity (Ackerman 1991).

K-2.1.6.1 Groundwater Flow. The elevation of the water table for the SRPA is depicted in Figure K-15. Groundwater flow is to the south-southwest; however, locally, the direction of groundwater flow is affected by recharge from rivers, surface water spreading areas, and heterogeneities in the aquifer.

Vertical-head gradients are usually less than 0.01 over the first 61 m (200 ft) and less than 0.02 over the first 168 m (550 ft) of saturated thickness. Across the INEEL, the horizontal gradient of the water table ranges from 1 to 15 (average is about 0.75 m/km [4 ft/mi]) (Ackerman 1991). Horizontal groundwater flow velocity ranges from 1.5 to 7.6 m/day (5 to 25 ft/day); however, most of the flow ranges from 1.5 to 3 m/day (5 to 10 ft/day) (Robertson et al. 1974). Data from Mundorff et al. (1964) indicate that about 56.6 m^3/sec (2,000 ft^3/sec) flow beneath the INEEL at its widest point.

Estimating the direction and rate of groundwater flow in the SRPA is complicated by the anisotropic and heterogeneous nature of the SRP basalts. Sedimentary interbeds that are often clay-rich and impede the movement of groundwater further complicate flow in the aquifer. However, locally coarse-grained interbeds may be more permeable than some basalt. On a sufficiently large scale the heterogeneities of the basalts and sediments of the SRPA average out, and groundwater flow and transport can be predicted using numerical models. At local and intermediate scales, complex flow patterns resulting from the complex geology can become apparent. Anomalous features are artifacts of the complex water table, lack of sufficient well control, and well deviation and are commonly observed. At small-scales and small contour intervals, the water table of the SRPA can be complex. This complexity reflects the variety and degree of interconnecting water-bearing zones that may affect the water table at a local scale but average out on a regional scale.

Very few dispersivity values have been measured at the INEEL. However, because of the heterogeneous nature of the SRPA, dispersivity values measured over relatively small areas (about 100 m [328 ft]) may only be representative of the specific region in which they were measured. Dispersivity values have been obtained by calibrating numerical transport models against observed contaminant transport. Till and Meyer (1983) list a longitudinal dispersivity of 91 m (298.5 ft) and a transverse dispersivity of 136 to 137 m (446 to 449 ft) as representative of the INEEL lava flows and sediments. Because dispersivity valves are scale and site dependent, a range of values may be reported for the same site when modeling at different scales. For instance, recent modeling at TAN reported values for longitudinal and transverse dispersivities that were several times smaller than those reported above.

K-2.1.6.2 Recharge and Discharge. Recharge to the SRPA near the INEEL originates from precipitation in the mountains to the north and west. Most of the inflow occurs as underflow from alluvial-filled valleys along the edges of the ESRP. The Big Lost River, Little Lost River, and Birch Creek terminate at sinks on or near the INEEL and recharge the aquifer. Recharge occurs through the surface of the plain from flow in the channel of the Big Lost River and its diversion areas.

Additionally, recharge may occur from melting of localized snowpacks during years in which snowfall accumulates on the ESRP.

Recharge to the aquifer in the vicinity of the INEEL is closely linked to the amount of precipitation, particularly snowfall, for a given year. Historically, recharge from rivers has occurred during wet cycles that last from a few to several years. The intervening years produce little recharge.

K-2.1.7 Water Use and Supply

K-2.1.7.1 Water Rights. Management of Idaho groundwater resources to meet the State's present and future needs is under the direction of the Idaho Department of Water Resources (IDWR). IDWR is

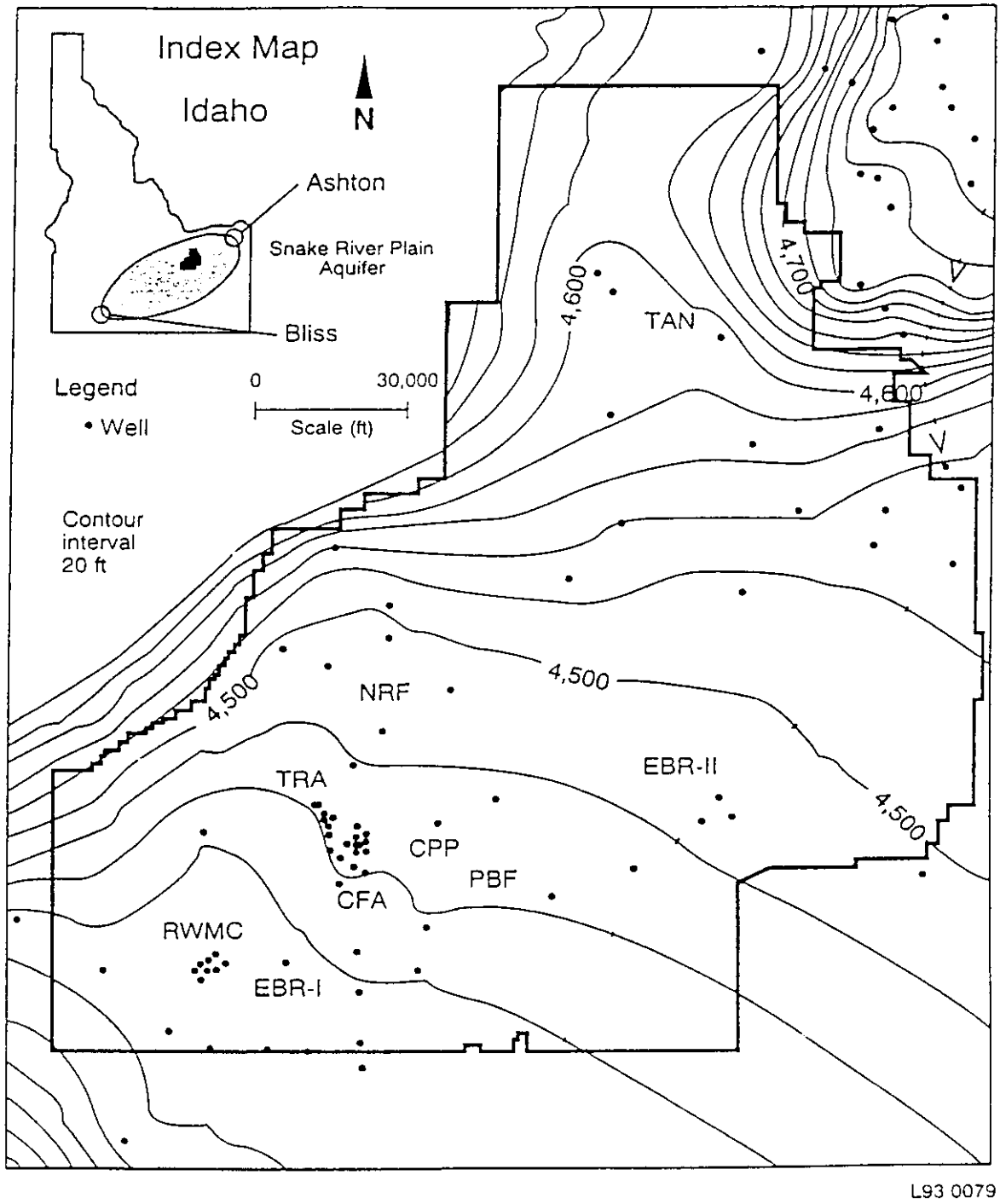


Figure K-15. Ground water table map for the INEEL and vicinity, May 1989.

empowered to establish groundwater management areas (GWMA) when public concern over declining groundwater levels warrants limiting development. If the decline is at a rate that threatens a reasonably safe supply for existing users, a critical groundwater area (CGMA) may be established in which no new well permits are issued, and groundwater withdrawals are limited to levels determined by the IDWR.

The earliest groundwater rights recorded on the SRP date from the early 1900s. Most groundwater rights, however, date from the 1940s and 1950s when groundwater irrigation became economical. The vast majority of all appropriations are irrigation rights followed by commercial appropriations.

The INEEL holds a Federal Reserved Water Right, which permits a pumping capacity of 2.26 m^3/sec (80 ft^3/sec) and a maximum consumptive use of 4.31E+07 m^3/yr (35,000 acre-ft/yr). Because it is a Federal Reserved Water Right, the priority dates to the establishment of the INEEL. The water is used for drinking, process water, and noncontact cooling water. Groundwater use at the INEEL is a relatively small component of the total pumpage from the SRPA.

K-2.1.7.2 Water Use. Groundwater use on the SRP is dominated by irrigation. According to Solley and others (1983), about 96 percent of consumptive water use in Idaho during 1980 was for irrigation, 3 percent was for self-supplied industries, and 1 percent was for public water supplies. Eighty-five percent of Idaho's irrigated acreage is on the Snake River Plain. (Lindhom, 1996). In 1985, Idaho alone accounted for more than 15 percent of the total agricultural withdrawals in the nation. (Solley et al., 1983).

The use of groundwater for irrigation has altered the hydrological system of the SRP. Water levels in wells have decreased due to more efficient irrigation distribution and annual increases in groundwater pumpage since the 1950s. Flow modeling was used to simulate pre-irrigation hydrologic conditions and to determine probable aquifer response to hypothetical future water-resource development in the eastern plain. According to Lindholm (1981), who modeled aquifer response to irrigation, if 1980 conditions of recharge and discharge are extended to the year 2010, aquifer declines of 0.61 to 2.4 m (2 to 8 ft) could be expected. However, if withdrawals were increased by 67.96 m^3 (2,400 cfs) in order to irrigate another 404,700 ha (1 million acres), head declines of 3.04 to 15.24 m (10 to 50 ft) might be expected within 30 years.

In 1980, about 1.25E+08 m^3 (102,000 acre-ft) of water was withdrawn on the SRP for nonindustrial public supply uses. More than 95% of public supply is groundwater (Goodell 1988). Because groundwater supplies 100% of the drinking water consumed within the ESRP (Gaia Northwest 1988) and because an alternative drinking water source or combination of sources is not available, the EPA Region 10 designated the SRPA a sole source aquifer in 1991 (EPA 1991).

EPA Region 10 defines a sole source aquifer as one that supplies 50% of the drinking water consumed in the area overlying the aquifer. Current guidelines stipulate that designated sole source aquifers have no alternative source or combination of sources that could physically, legally, and economically supply all those who obtain their drinking water from the aquifer. Because the SRPA has been designated as a sole source aquifer, no commitment for federal financial assistance may be entered into for any project that EPA Region 10 determines may contaminate the aquifer through a recharge zone so as to create a significant hazard to public heath.

Groundwater withdrawals at INEEL averaged about 9.12E+06 m^3/yr (7,400 acre-ft/yr) from 1979 to 1981 (Lewis and Jensen 1984). About 90% were withdrawn in Butte County and 10% in Bingham and Jefferson Counties. Consumptive use was 37%, or 4.8E+06 m^3 (3,900 acre-ft). The remaining 63% was discharged to the aquifer through disposal wells (discontinued in 1984) and infiltrate ponds (still in use) (Pittman et al. 1988).

Total water use for the upper Snake River drainage basin and the SRPA was 4.5E+07 m^3 (36,514.27 acre-ft) for 1985, which was over half the water used in Idaho and about 7% of agricultural withdrawals in the nation. Total estimated groundwater pumpage from the SRPA in 1980 is shown in Figure K-16.

K-2.2 Natural Water Chemistry

The natural groundwater chemistry of the SRPA beneath the INEEL is determined by (a) the chemical composition of groundwater originating outside of the INEEL, (b) the chemical composition of precipitation falling directly on the land surface, (c) the chemical composition of streams, rivers and runoff infiltrating into the aquifer, and (d) the weathering reactions that occur as water interacts with the minerals composing the aquifer (Wood and Low 1986, 1988).

Figure K-17 shows the hydrogeochemical zones of groundwater beneath the INEEL. Groundwater entering the INEEL from the northwest contains calcium, magnesium, and bicarbonate because this water has been in contact with sedimentary rocks containing these compounds. Groundwater entering the INEEL from the east contains sodium, fluorine, and silicate because it has been in contact with volcanic rocks containing these compounds (Robertson et al. 1974).

The influence of direct precipitation on the SRPA is small because total precipitation on the SRP is generally low, and evaporation rates in this region are high. The concentration of dissolved compounds, such as calcium and sodium, in precipitation is generally much lower than that of rivers and streams where the water has had greater contact with soluble minerals (Wood and Low 1988).

The Big Lost River, the Little Lost River, and Birch Creek infiltrate into the northern and western portions of the INEEL. Infiltration of these surface waters into the SRPA tends to increase calcium and magnesium concentrations while diluting silicate and sodium concentrations (Robertson et al. 1974).

Calculations suggest that about 20% of all dissolved compounds leaving the SRPA result from weathering reactions within the aquifer. These weathering reactions include dissolution of minerals, such as olivine and anhydrite, as well as precipitation of calcite and silica (Wood and Low 1986, 1988). The remaining 80% of dissolved compounds present in water leaving the SRPA originate from the three sources previously described: (1) groundwater originating from outside the SRP, (2) infiltration of surface water, and (3) precipitation on the land surface. Groundwater originating outside the SRP and infiltration of surface water are the primary sources.

Mean, maximum, and minimum concentrations of the major naturally occurring dissolved compounds observed in the SRPA beneath the INEEL are listed in Table K-6. Figures K-18 through K-21 show the spatial distribution of temperature, total dissolved solids, calcium, and sodium in the SRPA beneath the INEEL.

The natural groundwater composition beneath the INEEL may have a significant affect on the mobility of contaminants introduced into the subsurface of the INEEL by human activity. Most dissolved contaminants adsorb to the surface of the rocks and minerals that make up the aquifer. This adsorption retards the movement of these contaminants through the aquifer. Many naturally occurring compounds either compete with the contaminants for adsorption sites on the rocks and minerals or react with the contaminants to reduce their attraction to the rock and mineral surfaces. For example naturally occurring calcium may effectively compete with Sr-90 (introduced by human activities) for rock and mineral adsorption sites, thus, resulting in more rapid Sr-90 movement through the aquifer.

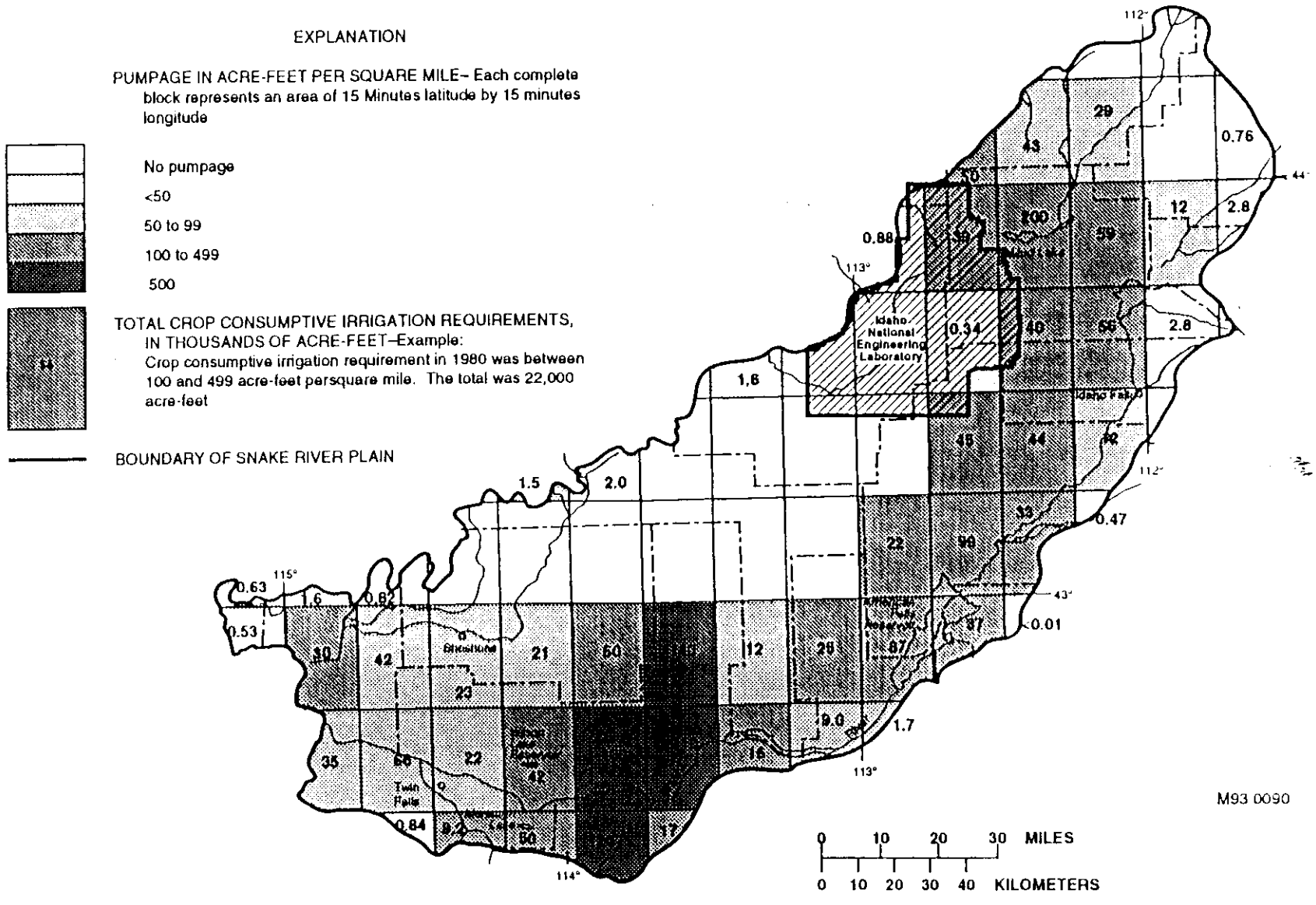


Figure K-16. Map indicating pumpage per square mile for the SRPA (darker areas indicate more intense pumpage).

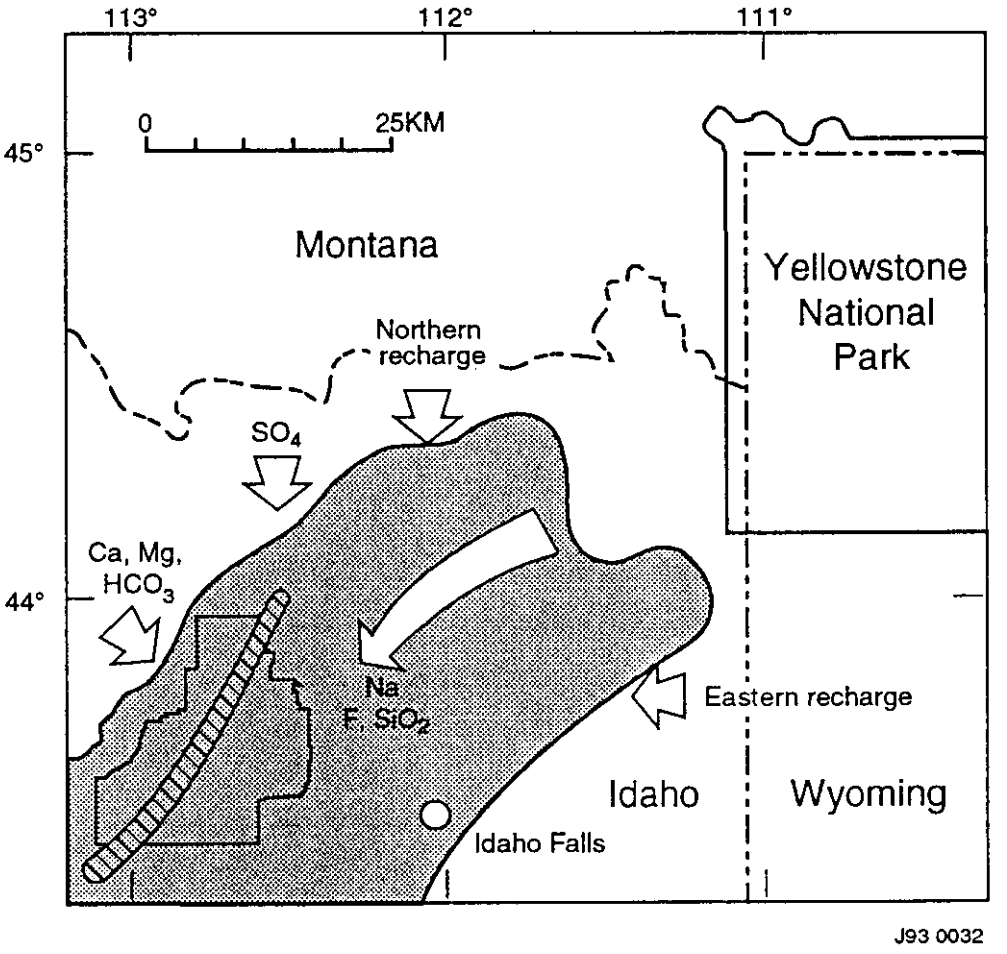


Figure K-17. Hydrogeochemical zones of groundwater in the SRPA beneath the INEEL.

Table K-6. The mean, maximum, and minimum concentrations of dissolved compounds in the groundwater of the SRPA.[a]

Parameter	Mean[b] (mg/L)	Maximum (mg/L)	Minimum (mg/L)
Calcium	51	350	1.7
Magnesium	17	170	0.1
Sodium	43	570	2.7
Potassium	5	150	0.0
Bicarbonate	222	1,090	3.0
Chloride	32	700	0.5
Sulfate	67	1,400	0.8
Silica	37	140	0.2
Dissolved solids	366	2,440	60

a. Table taken from Wood and Low (1988).

b. The mean, maximum, and minimum of 711 analyses.

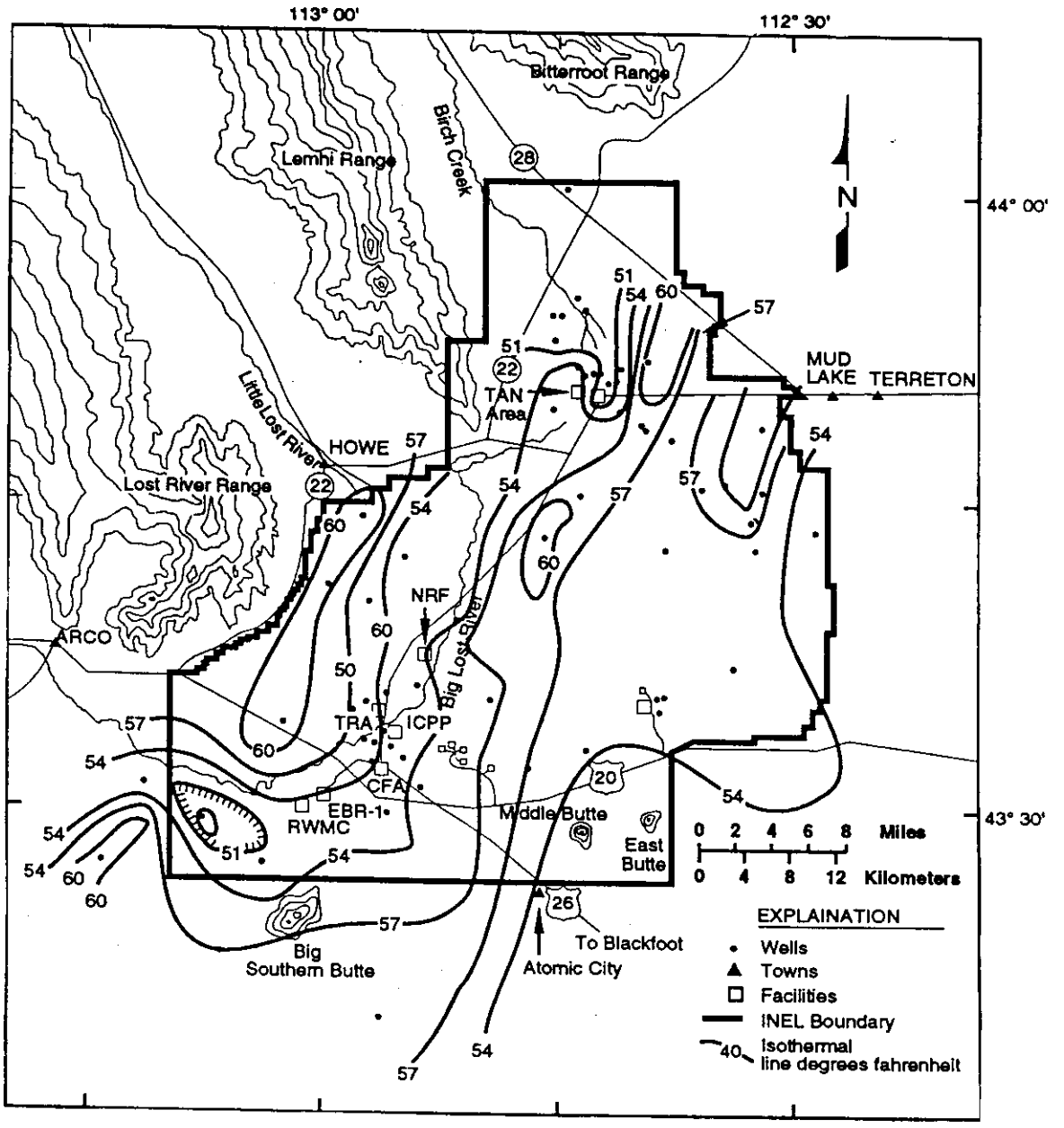


Figure K-18. Spatial distribution of temperature in the SRPA beneath the INEEL.

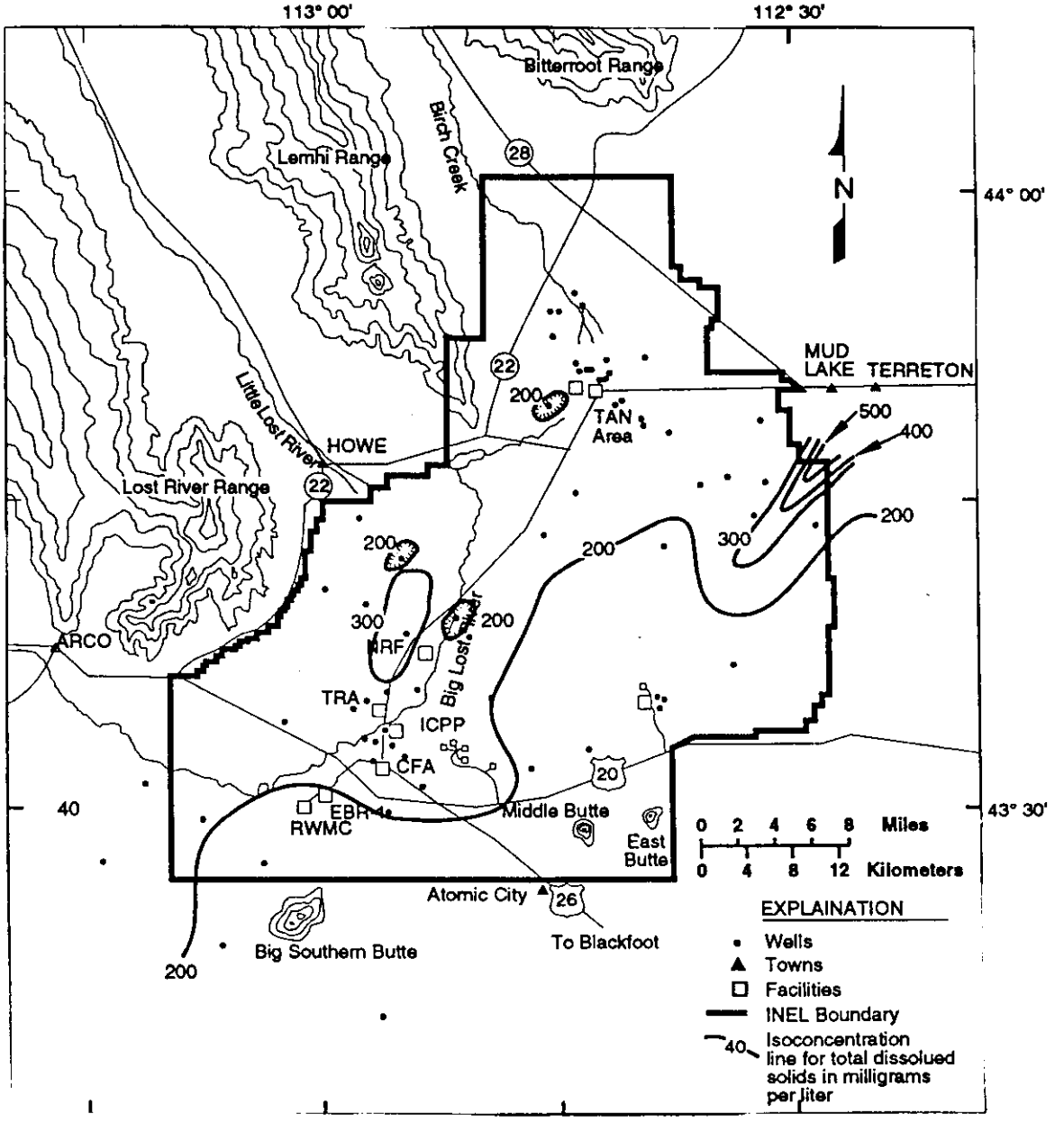


Figure K-19. Spatial distribution of dissolved solids in the SRPA beneath the INEEL.

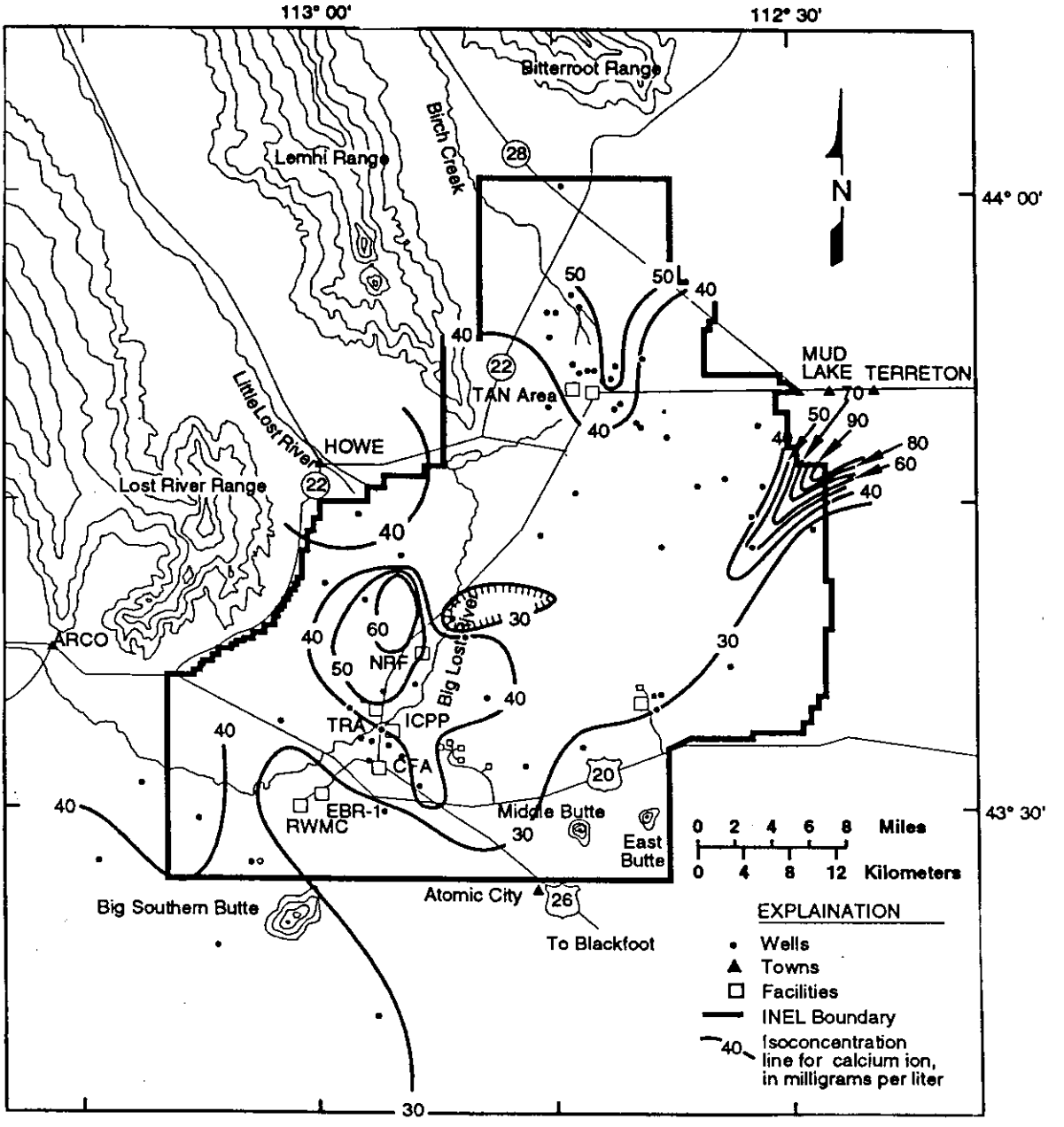


Figure K-20. Spatial distribution of calcium in the SRPA beneath the INEEL.

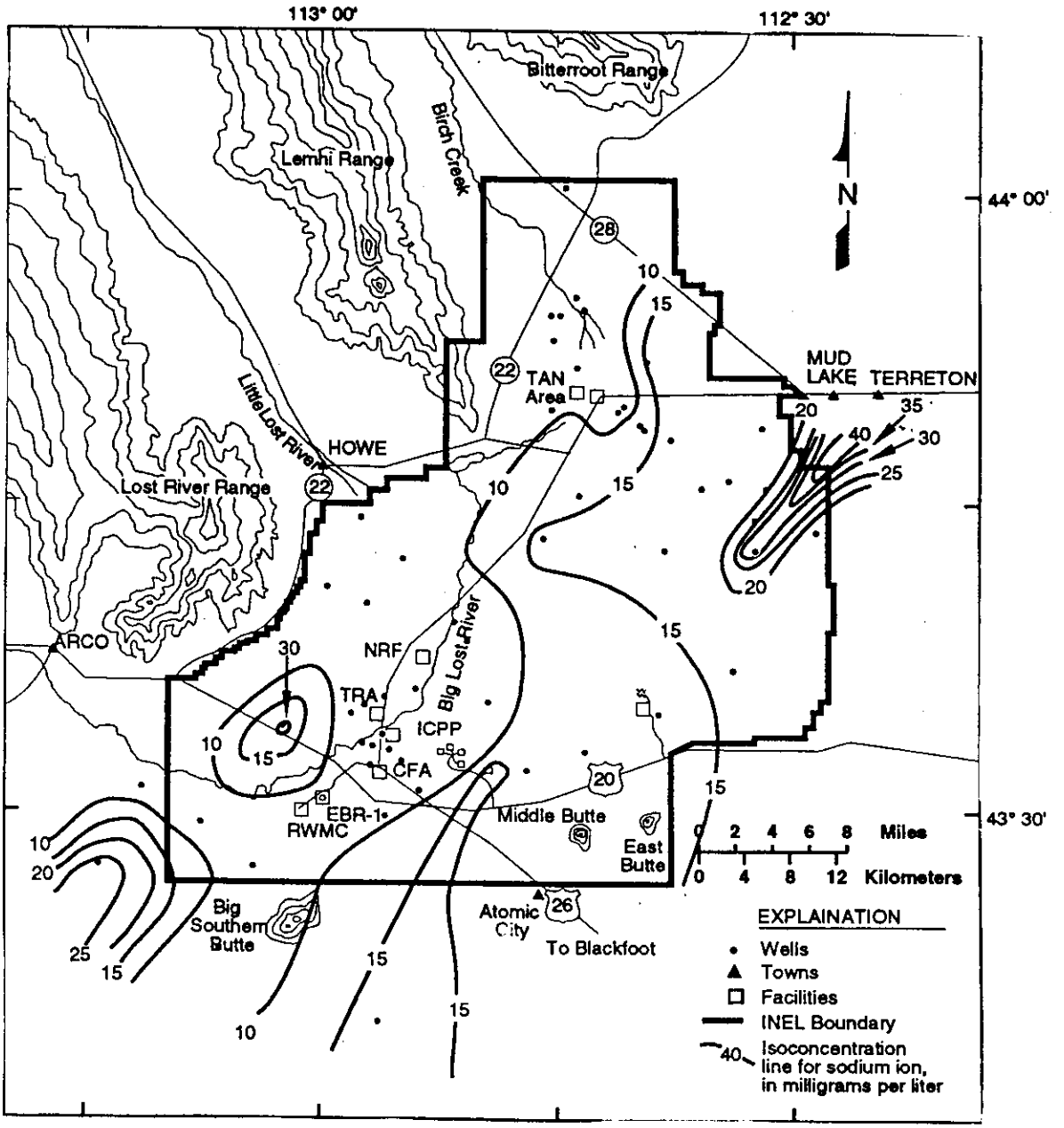


Figure K-21. Spatial distribution of sodium in the SRPA beneath the INEEL.

K-2.2.1 Groundwater Contamination

The sitewide groundwater analysis portion of the OU 10-04 RI/FS has been deferred to OU 10-04B, so the information presented in this section will be updated during the OU 10-04B Work Plan. This update will address recent data such as nitrates in groundwater at CFA and ongoing remediation at TAN.

In addition to the naturally occurring compounds found in the SRPA beneath the INEEL, human activities at the INEEL have introduced radioactive compounds, nonradioactive metals, inorganic salts, and organic compounds into the subsurface materials and groundwater at the INEEL.

Radionuclides released and observed in the soils and groundwater of the INEEL include tritium, Sr-90, I-129, Co-60, Cs-137, Pu-238, Pu-239/240, and Am-241. Radionuclide concentrations in the SRPA beneath the INEEL have generally decreased since the middle 1980s. These reduced concentrations have resulted from changes in INEEL disposal practices, radioactive decay, adsorption of the radionuclides to the surfaces of rocks and minerals within the aquifer, and dilution by natural surface and groundwaters entering the SRPA (Pittman et al. 1988; Orr and Cecil 1991).

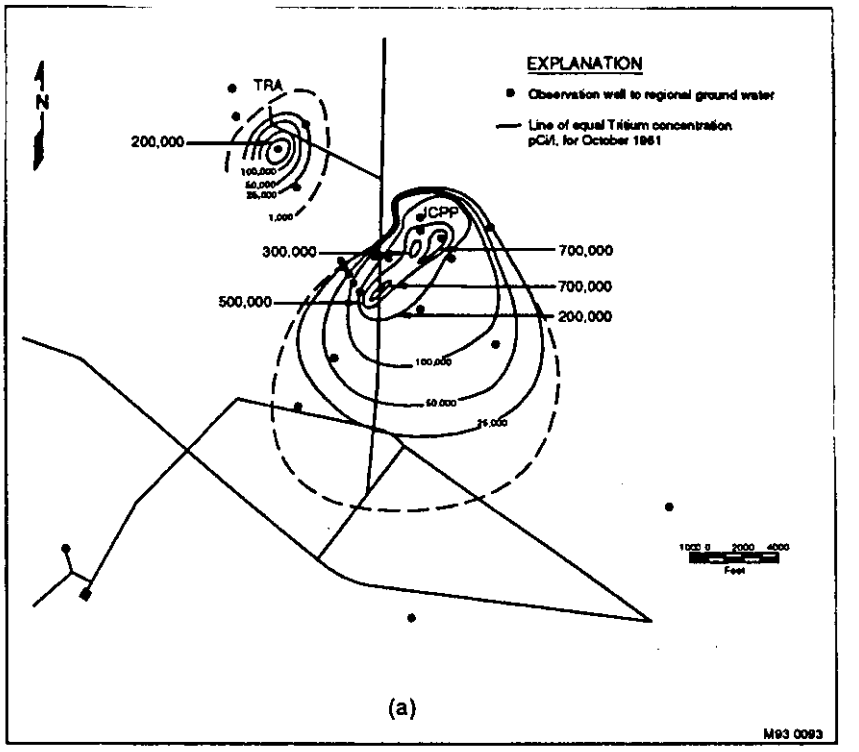
Figure K-22 shows the spatial distribution of tritium in the SRPA beneath the INEEL for the years 1961, 1968, 1985, 1988, and 1995. The principal sources of tritium in the aquifer have been the injection of wastewater through the INTEC disposal well and the discharge of wastewater to the infiltration ponds at the INTEC and TRA. About 31,750 Ci of tritium has been discharged to the well and ponds since 1952. Routine use of the disposal well ended in February 1984. Since then most radioactive wastewater has been discharged to the infiltration ponds. During 1992–95, approximately 0.3 Ci of tritium was discharged to the ponds at the INTEC and about 430 Ci was discharged to the ponds at the TRA (Bartholomay et al. 1997).

Tritium travels through the aquifer at a rate similar to the groundwater because it does not adsorb to rock or mineral surfaces. Therefore, tritium has migrated further than almost all other compounds, such as VOCs, SVOCs, metals, etc., introduced to the subsurface environment by human activities at the INEEL. Natural concentrations of tritium occurring in the SRPA generally range from 75 to 150 pCi/L (Orr et al. 1991). Tritium has a half-life of 12.26 years.

In October 1995, concentrations of tritium in water greater than the reporting level ranged from 0.6±0.2 to 25.1±1.0 pCi/mL and the tritium plume extended southwestward in the general direction of groundwater flow (Figure K-22). The area of the tritium plume which concentrations exceed 0.5 pCi/mL decreased form about 45 mi^2 in October 1988 to about 40 mi^2 in October 1991 (Bartholomay et al. 1995). In October 1995, the area remained approximately the same as in 1991. The area of the plume in which tritium concentrations exceeded the maximum contaminant level (MCL) of 20 pCi/mL was 2.4 mi^2 in 1991. In 1995, five water samples collected by the USGS exceeded the MCL. However, because the wells were not located in the same area, no plume was discernable (Bartholomay et al. 1997).

Long-term radioactive decay processes and overall decrease in tritium disposal rates have contributed to decreased concentrations of tritium and the decreased area of the tritium plume at the INEEL in 1992–95. Of the total, 31,750 Ci of tritium discharged to the aquifer from 1952 to 1995, approximately 7,500 Ci remained after radioactive decay. The average combined rate of tritium disposal at the TRA and INTEC during 1952–95 was 722 Ci/yr. The average combined rate was 222 Ci/yr during 1984–95 and 107 Ci/yr during 1992–95 (Bartholomay et al. 1997).

Figure K-23 shows the distribution of Sr-90 in the SRPA for years 1964, 1970, 1985, 1988, and 1995. Unlike tritium, strontium adsorbs to rock and mineral surfaces and, thus, has not migrated through



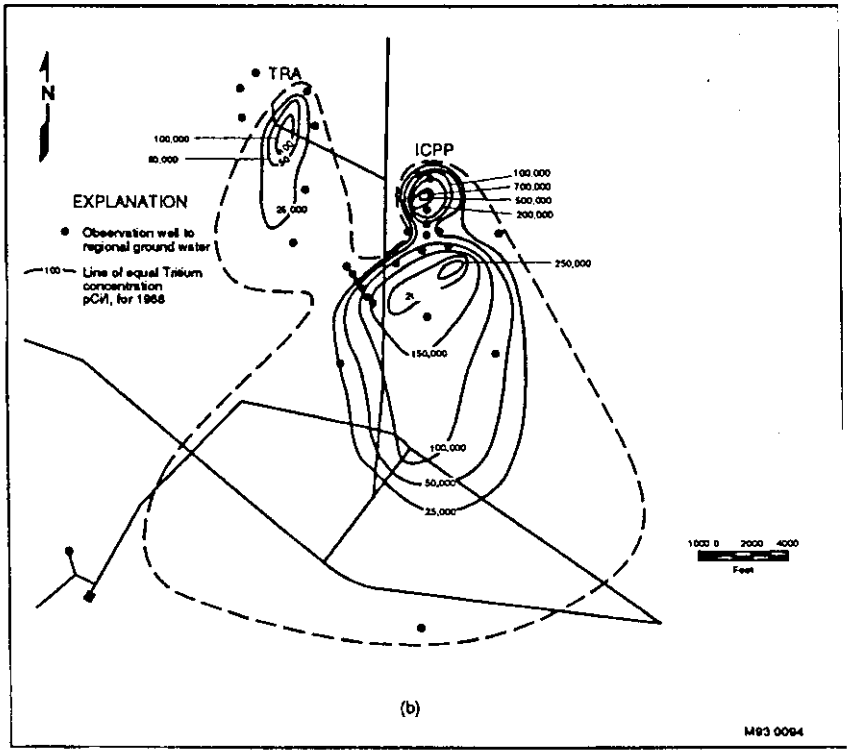


Figure K-22. Spatial distribution of tritium in the SRPA beneath the INEEL for the years 1961 (a), 1968 (b), 1985 (c), and 1988 (d).

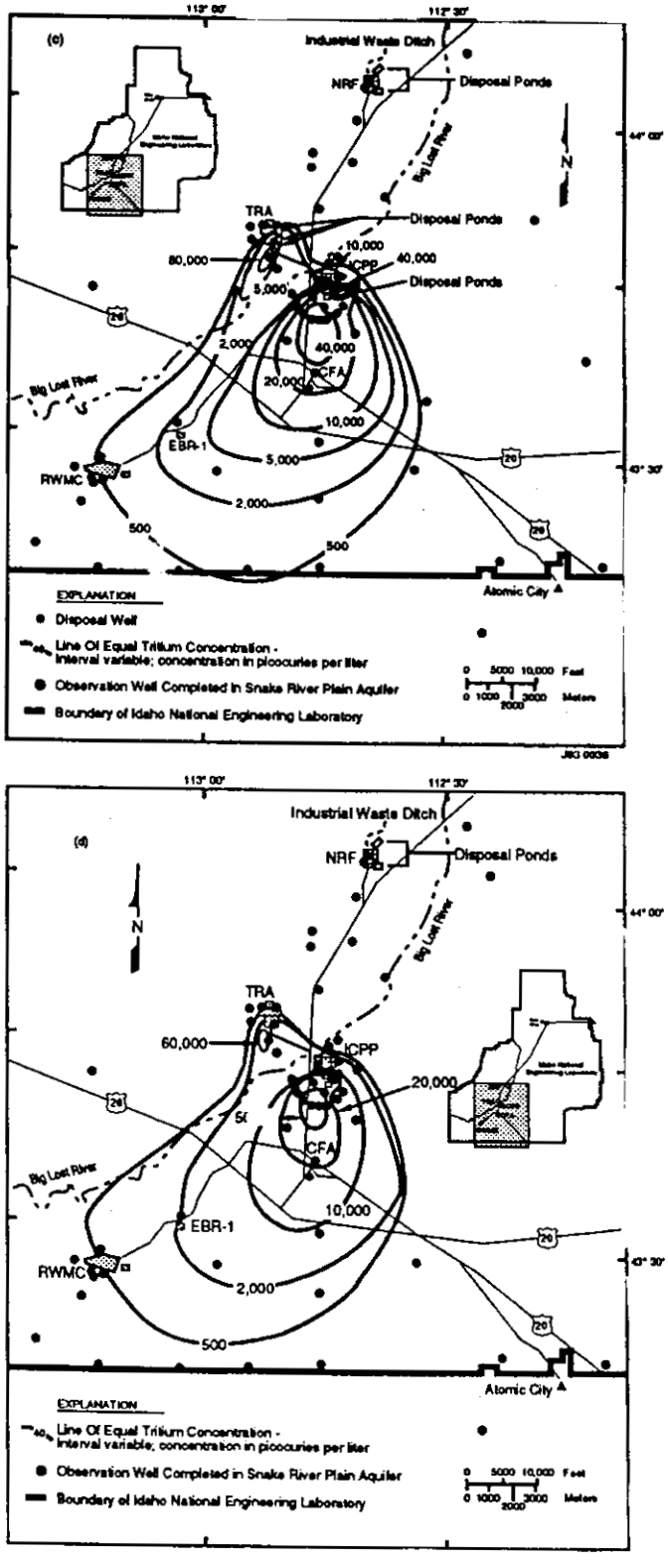


Figure K-22. (continued).

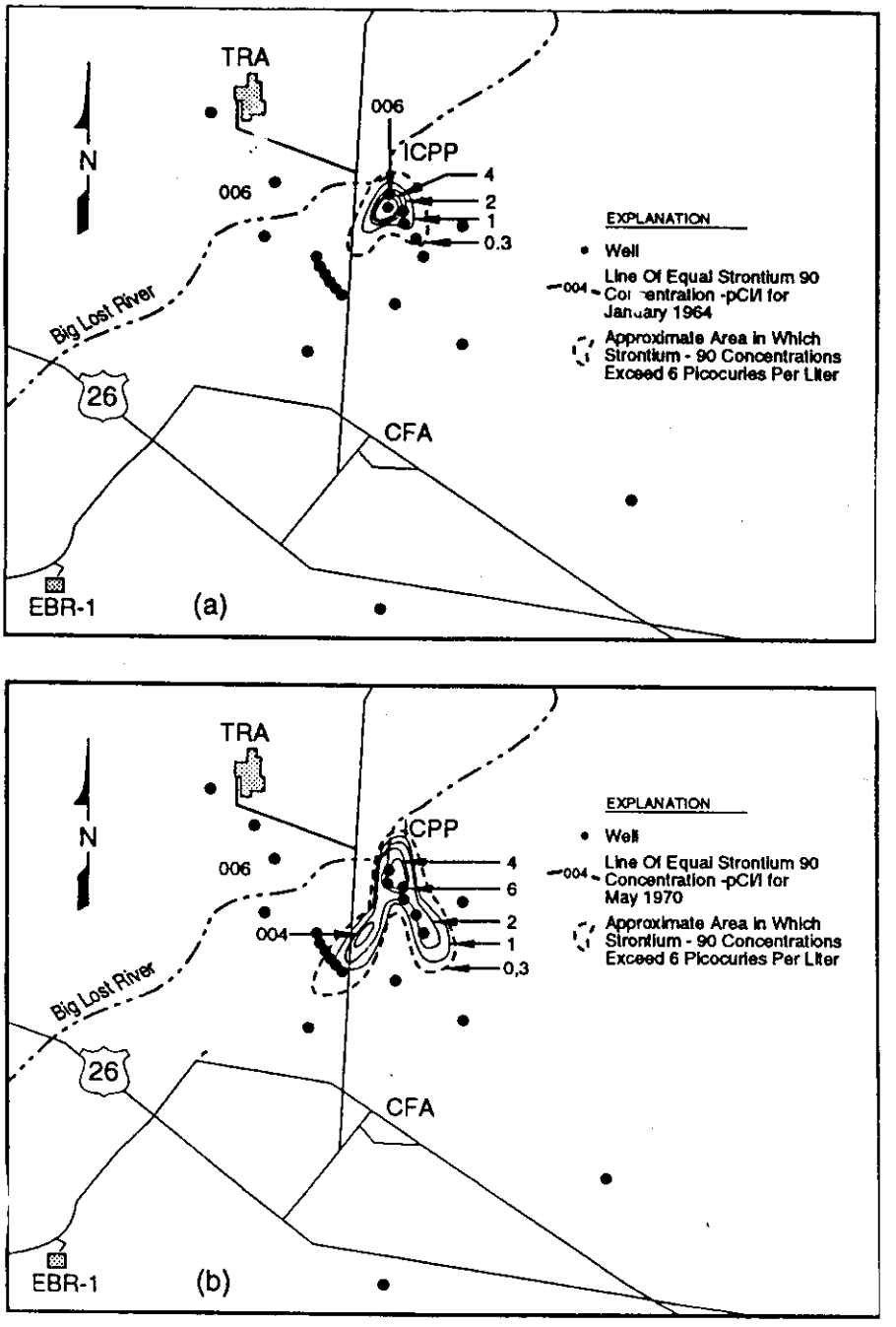
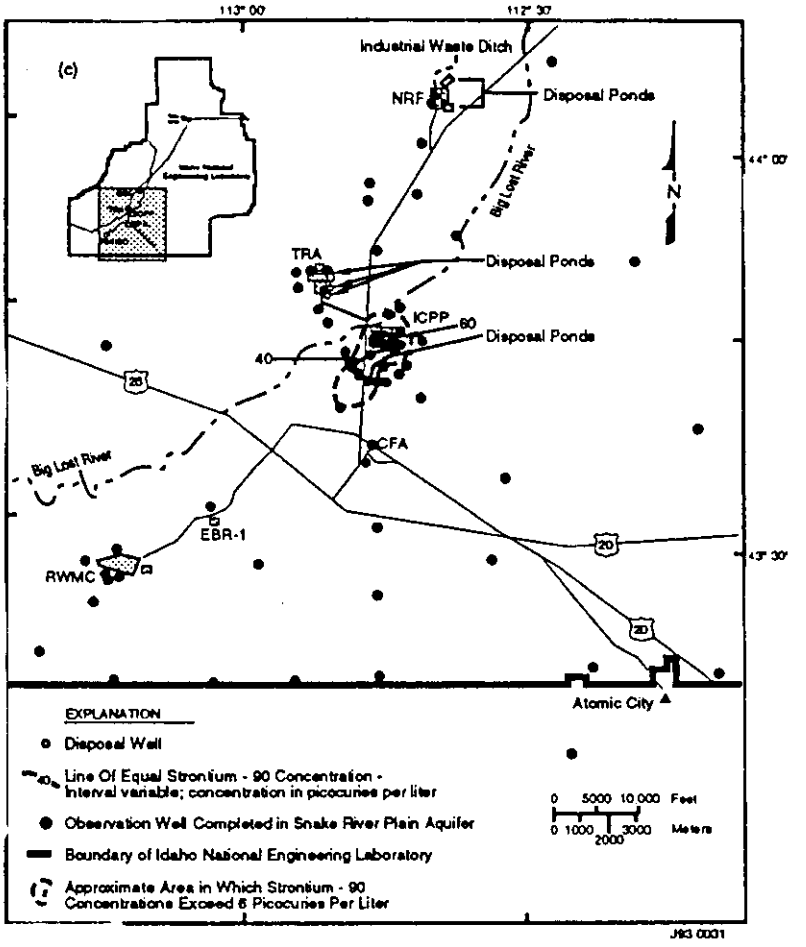


Figure K-23. Spatial distribution of Sr-90 in the SRPA for the years 1964 (a), 1970 (b), 1985 (c), and 1988 (d).



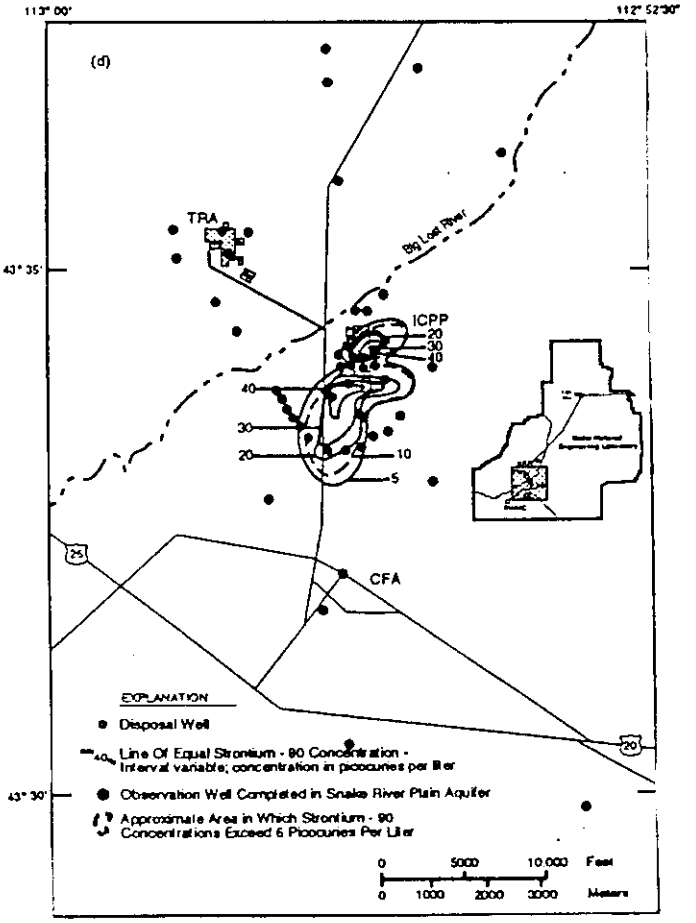


Figure K-23. (continued).

the SRPA as far as tritium. Sr-90 does not naturally occur in groundwater. The half-life of Sr-90 is 28.6 years.

During 1962–63, more than 33 Ci of strontium-90 in wastewater was discharged into a pit at the ICPP (now INTEC) (Robertson et al. 1974). In addition, during 1952–95, about 24 Ci of strontium-90 was in wastewater injected directly into the aquifer through the INTEC disposal well and discharged to infiltration ponds at the INTEC (Bartholomay 1997). Approximately 93 Ci of strontium-90 was discharged to radioactive waste infiltration and evaporation ponds at the TRA during 1952–95. During 1992–95, about 0.32 Ci of strontium-90 was discharged to infiltration ponds at the INEEL; most of which was discharged to the TRA infiltration and evaporation ponds (Bartholomay 1997).

In October 1995, water from 19 wells had concentrations of strontium-90 greater than the reporting level. Concentrations ranged from 2.6±0.7 to 76±3 pCi/L. Concentrations of strontum-90 in water samples from most wells have remained relatively constant since 1989. The October 1995 concentration of 76±3 pCi/L in water from well USGS-47 was a higher concentration than previous samples, however, the quality-assurance replicate concentration of 47±2 pCi/L was consistent with concentrations in previous samples (Bartholomay 1997). The MCL for strontium-90 in drinking water is 8 pCi/L.

The maximum I-129 concentrations observed in the SRPA were 27 ± 1 pCi/L in 1977, 41 ± 2 pCi/L in 1981, and 3.6 ± 0.4 pCi/L in 1986. The plume area has decreased from 2.1 km^2 (0.8 mi^2) exceeding 5 pCi/L in 1981 to 1.02 km^2 (0.4 mi^2) exceeding 3 pCi/L in 1986 (Mann et al. 1988). Mann (1994) has recently observed I-129 concentrations slightly higher than background concentrations, but much lower than the maximum contaminant level, 9.7 km (6 mi) outside the INEEL. Natural concentrations of I-129 occurring in the SRPA range from 0 to 0.05 pCi/L (Orr et al. 1991). I-129 has a half-life of 17 million years.

Measurable Co-60 concentrations were observed in Well 65 near the TRA through 1985. Cobalt has not been detected in this well since 1986. A Co-60 concentration of 890 ± 9 pCi/L was observed in the TAN disposal well in 1987 (Pittman et al. 1988; Orr and Cecil 1991). The half-life of Co-60 is 5.26 years. Cobalt-60 was detected in the TAN disposal well as recent as November 1994 at a concentration of 1,390 ± 100 pCi/L, but has not been detected in 1995 and 1996 sampling events. During 1992–95, Cobalt-60 concentrations in water from all wells sampled by the USGS at the INEEL were below the reporting level (Bartholomay 1997).

Cesium-137 was detected in two wells near the INTEC between 1982 and 1985. The maximum concentration observed was 237 ± 34 pCi/L. Cesium has not been detected in these wells after 1985. A Cs-137 concentration of 3,800 ± 160 pCi/L was observed in the TAN disposal well in 1986. In 1985, 3,060 ± 120 pCi/L of Cs-137 were observed in the TAN well. Although Cs-137 was also released at the TRA, it has never been observed in monitoring wells near the TRA (Pittman et al. 1988; Orr and Cecil 1991). Cesium -137 has a half-life of 30.23 years. Cesium -137 has been detected in several of the TAN wells ranging from below the method detection limit to over 2,000 pCi/L. Sampling of the TAN disposal well in 1996 and 1997 has yielded results ranging from approximately 1,600 to 600 pCi/L, respectively. During 1992–95, concentrations of Cesium-137 in water from all wells sampled by the USGS at the INEEL were below the reporting level (Bartholomay 1997), it should be noted, however, that the USGS typically does not sample within facility fences.

Measurable Pu-238 concentrations were observed in two wells near the INTEC before 1986. The highest concentration observed was 0.5 ± 0.06 pCi/L in 1983. No Pu-238 has been detected in these wells since 1986. A Pu-239/240 concentration of 5.5 ± 0.4 pCi/L was detected in one of these wells in 1987. Pu-239/240 has not been detected in either well since 1987. The Pu-238 concentration in the TAN

disposal well was 1.22 ± 0.09 pCi/L in 1987 and 0.19 ± 0.05 pCi/L in 1988. The Pu-239/240 concentration in the TAN disposal well was 5 ± 0.02 pCi/L in 1987 and 0.96 ± 0.08 pCi/L in 1988. A Pu-238 concentration of 0.11 ± 0.03 pCi/L was observed in a well near the CFA in 1987. No Pu-238 has been detected in the well since 1987 (Pittman et al. 1988; Orr and Cecil 1991). The half-lives of Pu-238, -239, and -240 are 86, 24,400, and 6,580 years, respectively. The March 1994 and June 1994 sampling did not show any Pu-238 nor Pu-239 detected in the TAN disposal well.

Americium-241 is a decay product of Pu-241. The half-life of Am-241 is 432 years. Measurable Am-241 was observed in four wells near the RWMC from 1972 through 1982. In 1987 and 1988, 2.1 ± 0.04 and 1 ± 0.03 pCi/L were observed in the TAN disposal well, respectively (Pittman et al. 1988; Orr and Cecil 1991).

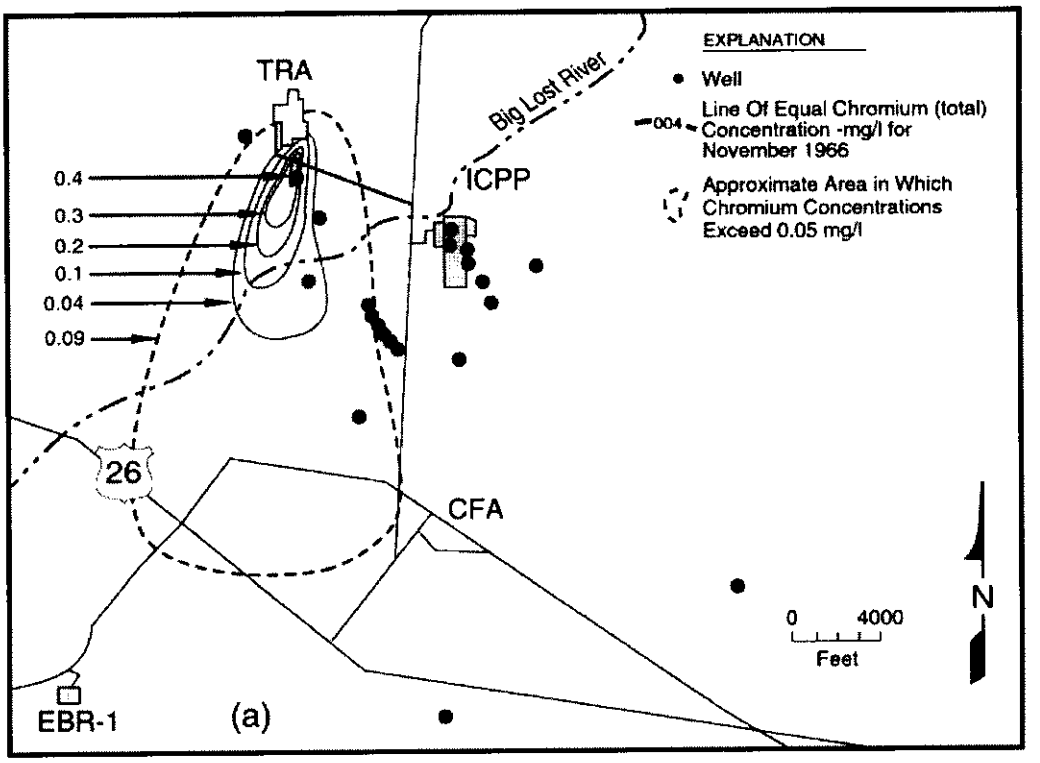
In October 1997, one groundwater sample was collected from a well near the Subsurface Disposal Area of RWMC showed the presence of americium-241. The americium-241 concentration of this sample was approximately 1 pCi/L. This well also showed americum-241 near 2 pCi/L in April 1998. The sampling frequency has subsequently been changed from semi-annually to quarterly.

The nonradioactive metals, sodium, chromium, mercury, and lead have been released into the subsurface by human activities at the INEEL. Of these metals, sodium was released in greatest quantity. It is estimated that a total of 123,400 kg (55,979 lb) of chromium, 750 kg (340 lb) of lead, and 810 kg (1790 lb) of mercury were discharged at the INEEL before 1984. None of these metals have been discharged by INEEL facilities since 1986. Approximately 7 million kg (3.2 million lb) of sodium were discharged at the INEEL between 1986 and 1988 (Orr and Cecil 1991). The highest lead and mercury concentrations measured in the SRPA beneath the INEEL in 1987 were 0.007 and 0.004 mg/L (Mann and Knobel 1988; Pittman et al. 1988; Orr and Cecil 1991). Natural concentrations of lead and mercury occurring in the SRPA beneath the INEEL are <0.005 and <0.0001 mg/L, respectively (Orr et al. 1991).

The natural distribution of sodium within the SRPA beneath the INEEL is shown in Figure K-21. From this figure, it can be seen that natural sodium concentrations are generally less than 10 mg/L. A plume of elevated sodium concentration in the northeastern portion of the INEEL is evident. This plume may be due to infiltration of irrigation water in the Mud Lake region northeast of the INEEL. The concentration of inorganic salts and nutrients are frequently concentrated in irrigation waters (Robertson et al. 1974; Edwards et al. 1990). Because sodium is not generally considered toxic, there are no federal drinking water standards for sodium. The maximum sodium concentration observed in a plume near the INTEC was 56 mg/L. The size of this plume has decreased from 17.6 to 6.5 km^2 (6.8 to 2.5 mi^2) between 1985 and 1988. Sodium concentrations greater than 10 mg/L have been observed in several wells near the RWMC. The maximum sodium concentration measured in a well near the RWMC was 52 mg/L. The maximum sodium concentration observed in wells near the NRF during 1988 was 114 mg/L. Sodium disposal from NRF decreased from about 189,600 kg (86,000 lb) in 1986 to about 30,860 kg (14,000 lb) in 1988 (Pittman et al. 1988; Orr and Cecil 1991).

Figure K-24 shows the distribution of chromium in the SRPA beneath the INEEL in 1966, 1967, and 1970. Although chromium has been discharged at the TRA, NRF, Experimental Breeder Reactor No. 2 (EBR-II), INTEC, and Power Burst Facility (PBF) at various times, measurable chromium concentrations have only been observed near the TRA.

The TRA Disposal Well disposed of wastewater from the cold waste sampling pit (TRA-764) into the SRPA until 1982, when the well was taken out of service and turned into a monitoring well. The total amount of chromium discharged to the disposal well from January 1, 1964 through December 31, 1972 is approximately 14,121 kg (31,131 lb). The amount of chromium discharged to the WWP is estimated at 8,070 kg (17,791 lb) (DOE-ID 1997).



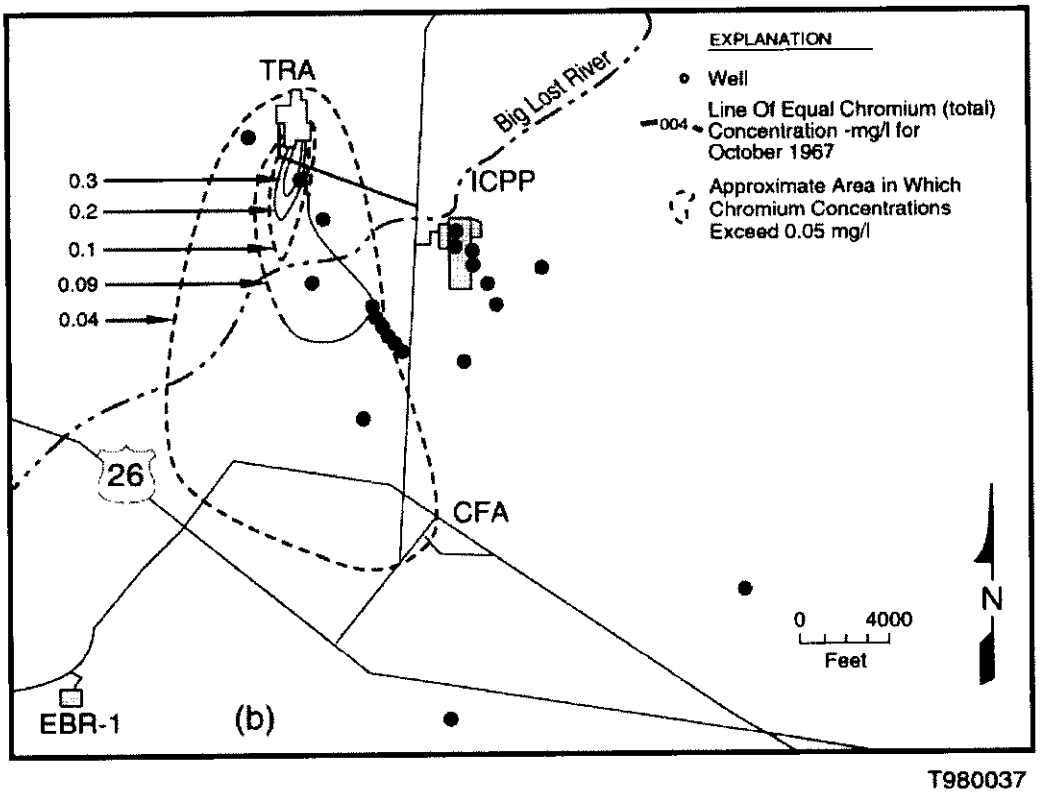


Figure K-24. Spacial distribution of chromium in the SRPA beneath the INEEL for the years 1966 (a), 1967 (b), and 1970 (c).

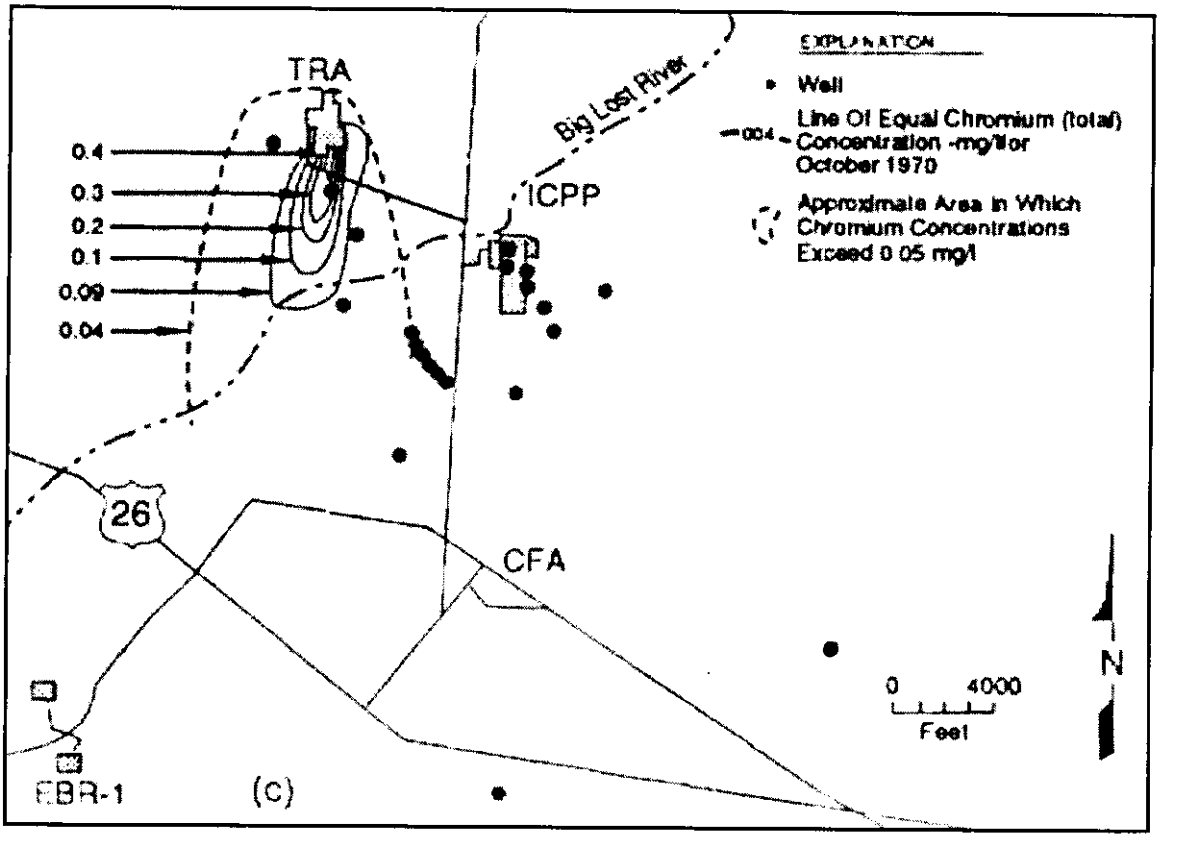


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Figure K-24. (continued).

Groundwater beneath the TRA has been monitored as part of the OU 2-12 post-ROD activities from 1993 through 1996. During the OU 2-12 monitoring, three wells completed in the SRPA (TRA-07, USGS-58, and USGS-65) were sampled quarterly for chromium. The maximum chromium concentration detected during this monitoring was 321 µg/L from well TRA-07. All chromium concentrations in wells TRA-07 and USGS-65 and several of the chromium concentrations in well USGS-58 exceed the INEEL background chromium concentration in the SRPA of 2 to 3 µg/L (Orr et al. 1991). From 1993 through 1996, chromium concentrations in the aquifer show a pattern of little change or decreasing concentration during the post-ROD monitoring period. Concentrations in wells TRA-07 and USGS-65 show a similar pattern, having concentrations of 170 µg/L and 151 µg/L, respectively (LMITCO 1998).

During the past three rounds of monitoring, chromium concentrations in the SRPA exceed the Idaho groundwater quality standard of 100 µg/L in wells TRA-07 and USGS-65, and in the January 1998 sample from well TRA-08. Chromium concentrations in these wells ranged from 157 to 185 µg/L in well TRA-07, 46.6 to 107 µg/L in well TRA-08, and 166 to 185 µg/L in well USGS-65 (LMITCO 1998).

Various inorganic salts containing chloride, sulfate, and nitrate have been released into the subsurface by human activities at the INEEL. Of these three, sulfate and chloride have been released in greatest quantity. The average annual discharge of sulfate and nitrate from the INEEL between 1992 and 1995 was approximately 1.05 million lb and 41,000 lb, respectively. Approximately 1.5 million lb of chloride were discharged from the INEEL annually between 1992 and 1995 (Bartholomay 1997).

Natural chloride concentrations occurring in the SRPA beneath the INEEL are generally 20 mg/L or less (Robertson et al. 1974). A plume of elevated chloride concentration occurs in the northeastern portion of the INEEL. Again, this concentration may be due to infiltration of irrigation water. Chloride concentrations as high as 150 mg/L have been measured in this plume (Robertson et al. 1974). A chloride plume near the INTEC decreased in size from about 44 to 24.6 km^2 (17 to 9.5 mi^2) between 1984 and 1988. The maximum chloride concentration observed in this plume in 1988 was 160 mg/L. A chloride concentration of 135 mg/L was observed in 1988 at a well near the NRF. Other chloride measurements near INEEL facilities were near or less than 20 mg/L (Pittman et al. 1988; Orr and Cecil 1991).

Natural sulfate concentrations occurring in the SRPA beneath the INEEL are less than 30 mg/L. A plume of elevated sulfate concentration occurs in the northeastern portion of the INEEL. Again, this may be due to infiltration of irrigation water. Sulfate concentrations in this plume are as high as 50 mg/L (Robertson et al. 1974). Although sulfate has been discharged into the subsurface of the INEEL, sulfate plumes have not been distinguishable from natural concentrations except for a few isolated locations. During 1985 water from a well near the NRF contained 67-mg/L sulfate and water from a well near the TRA contained 140-mg/L sulfate (Pittman et al. 1988; Orr and Cecil 1991). Because of the disposal history of sulfate at the various facilities, water sample collection for dissolved sulfate analyses at several wells was added to the water quality monitoring network in 1995. During 1995, sulfate concentrations in the water collected from three wells near the NRF, three wells near the TRA, and one well near the RWMC were greater than background concentrations. Water collected from wells NRF-6, NRF-2, and NRF-4 contained 230, 46, and 41 mg/L, respectively. Water samples from MTR Test, well USGS-65, and TRA Disposal contained 160, 150, and 45 mg/L of sulfate, respectively. The October 1995 water sample from well USGS-88 near the RWMC, contained 58 mg/L of sulfate (Bartholomay 1997). The proposed federal drinking water standard for sulfate is 400/500 mg/L.

Concentrations of nitrate in groundwater from regions of the INEEL not influenced by waste disposal are generally less than 5 mg/L. A plume of elevated nitrate concentration is observed in the northeastern portion of the INEEL (Figure K-25). Nitrate concentrations in this plume are as high as

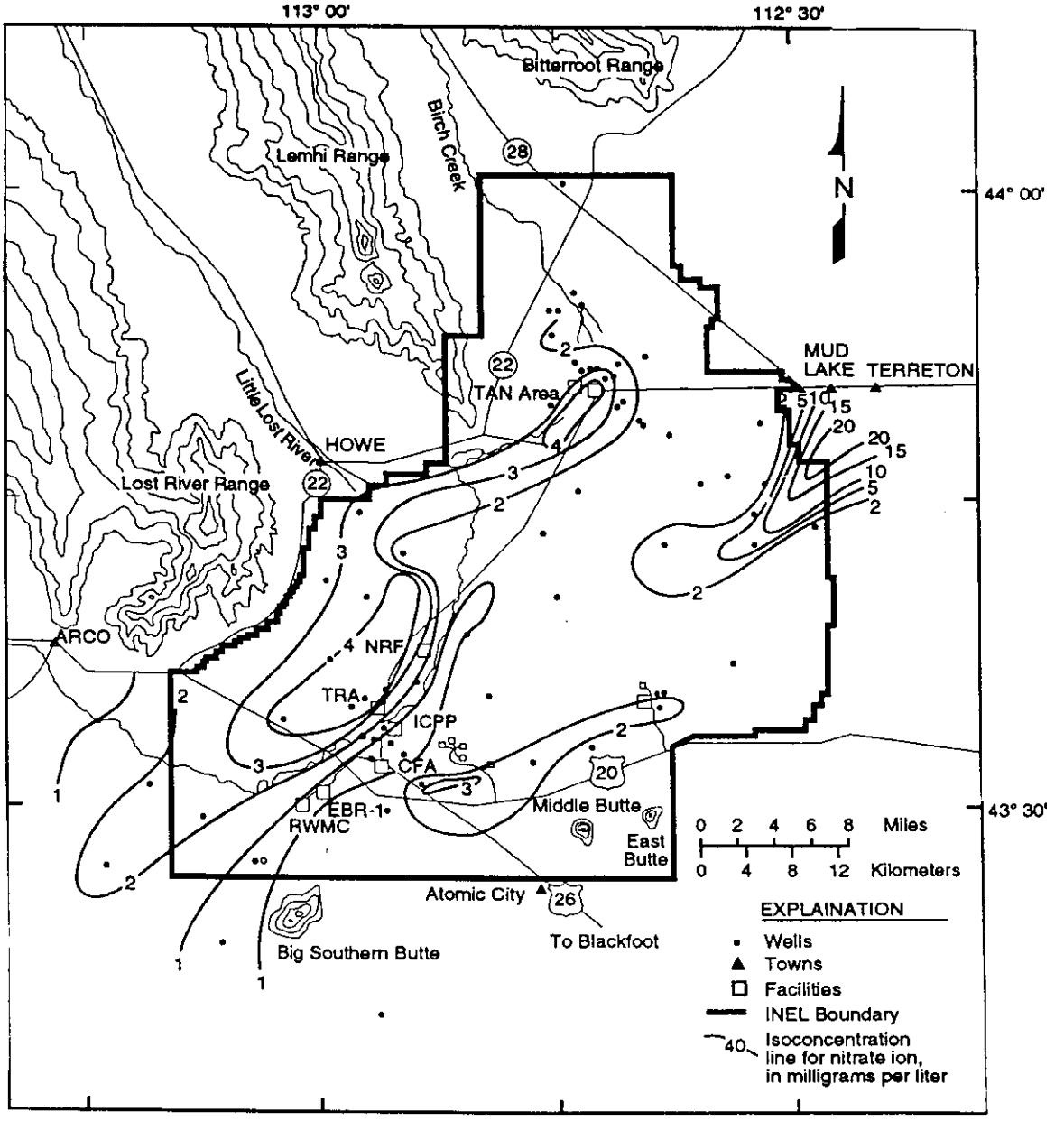

Figure K-25. Spatial distribution of nitrate in the SRPA beneath the INEEL.

20 mg/L. Again, these elevated nitrate concentrations may be due to the application of fertilizers and the infiltration of irrigation water in the Mud Lake region, northeast of the INEEL (Robertson et al. 1974, Edwards et al. 1990). The nitrate plume near the INTEC decreased in size from about 26 km^2 (10 mi^2) in 1982 to about 13 km^2 (5 mi^2) in 1988. The maximum plume concentration decreased from 62 mg/L in 1981 to 24 mg/L. During 1995 nitrate concentrations slightly higher than natural levels were observed near the RWMC (7.5 mg/L), TRA (6.6 mg/L), and NRF (9.3 mg/L) (Bartholomay 1997). The federal drinking water standard for nitrate (as nitrogen) is 10 mg/L. This corresponds to a nitrate concentration of approximately 44 mg/L. This corresponds to a nitrate concentration of approximately 44 mg/L. Concentrations of nitrate in water from one sample from well USGS-40 exceeded the MCL for drinking water at 49 mg/L.

Measurable concentrations of 19 organic compounds have been observed in the SRPA beneath the INEEL. The most frequently observed compounds are carbon tetrachloride, 1,1,1-trichloroethane, and trichloroethylene. Chloroform, tetrachloroethylene, dichlorodiflouromethane, toluene, 1,1-dichloroethane, 1,1-dichlororethyene, 1,2-dichloroethane, 1,2-transdichloroethylene, 1,1,2-trichloroethane, benzene, bromoform, methylene chloride, 1,4-dichlorobenzene, xylene, trichlorofluoromethane, 1,2-dichloropropane, ethylbenzen, 1,2-dichlorobenzene, and vinyl chloride also were detected in some groundwater samples (Leenheer and Bagby 1982; Mann and Knobel 1987; Mann 1990). During 1992–95, water samples were collected from 53 wells at or near the INEEL for various water quality studies. Water samples from 23 wells completed in the SRPA contained concentrations above the reporting level for 1 to 14 organic compounds (Bartholomay 1997).

Concentrations of most of these compounds were less than 0.002 mg/L. An isolated observation of a carbon tetrachloride concentration (0.0066 mg/L) slightly above the federal drinking water standard of 0.005 mg/L was made at a well near the RWMC during 1987. The carbon tetrachloride concentrations observed in this well during 1988 and 1989 ranged from 0.001 to 0.0041 mg/L (Mann and Knobel 1987; Mann 1990). From 1992 through 1997 Well M7S has exhibited carbon tetrachloride concentrations ranging from 0.103 to 0.006 mg/L. In October 1995, M10S showed a spike of 0.007 mg/L, but has historically averaged less than 0.003 mg/L.

A plume of 1,1,1-trichloroethane has developed in the SRPA near the INTEC. Ten of the wells near INTEC previously that had water with concentrations of 1,1,1-trichloroethane above the reporting level were sampled during 1992–95. Concentrations in water from 8 of the 10 wells were above the reporting level (Bartholomay 1997).

A plume of TCE has developed in the SRPA near TAN as a result of waste disposal practices. Major zones within the TCE plume have not measurably changed since 1995. Ongoing work at TAN, including statistical sampling of the distal portions of the plume, additional well drilling and sampling to refine TCE degradation rates, will lead to a better understanding of the extent and mobility of the plume. Planned well drilling and sampling will better define the leading edge and lateral plume boundaries and determine if plume geometry has changed due to dispersion and advection (Peterson et al, 1997).

The TAN disposal well exhibited elevated concentrations of trichloroethylene (35 mg/L in 1987 to 24 mg/L in 1989), tetrachloroethylene (0.17 mg/L in 1987 to 0.1 mg/L in 1988), 1,1-dichloroethylene (0.049 mg/L in 1987 to 0.025 in 1989), 1,2-dichloroethylene (22 mg/L in 1987 in 13 mg/L in 1988), and vinyl chloride (0.027 mg/L in 1989). Vinyl chloride frequently results from the degradation of organic compounds such as those observed in the TAN well (Mann and Knobel 1987; Mann 1990).

K-2.2.1.1 Vadose Zone. A very complex, heterogeneous vadose zone exists at the INEEL. It is an important component of the INEEL hydrologic system. Insight into the importance of the vadose zone can be gained by examining its role in (a) filtration of contaminants, (b) buffering of dissolved chemical

wastes and (c) transport of water and contaminated liquids. This thick vadose zone protects the groundwater by acting as a filter and preventing many contaminants from reaching the aquifer. The contaminants are immobilized through chemical sorption to vadose zone materials. Under dry conditions, the vadose zone acts as a buffer by providing storage for large volumes of liquid or dissolved contaminants that have spilled on the ground, migrated from disposal pits and ponds, or have otherwise been released to the environment. Finally, the vadose zone is important because transport of the contaminants through the thick, mostly unsaturated materials can be very slow if dry conditions prevail. It should be noted, however, preferred pathways for water movement in the vadose zone depend on the water content. If the water content is high (saturated conditions), water can move rapidly through open fractures and other void spaces.

Travel time for water through the vadose zone depends upon the interrelationship between unsaturated hydraulic conductivity, water content, and matric suction. An investigation into water movement during unsaturated flow regimes in undisturbed sediments near the RWMC using the Cl-36 isotope found that infiltration ranged from 0.36 to 1.1 cm/yr (0.16 to 0.49 in./yr) (Cecil et al. 1992). However, at the same undisturbed area Kaminsky (1991) found that standing water at land surface moved under a nearly saturated regime 210 cm (6.9 ft) in less than 24 hours. Bishop (1991) measured moisture movement in a 50-cm (20-in.) long basalt block from the RWMC. Under saturated conditions and matrix flow, over 100 days were required for saturation to occur. During the Large Scale Aquifer Pumping and Infiltration test, the average velocity of the wetting front through 180 ft of sediment and basalt under ponded condition was 5 m/day (16.4 ft/day) (Wood and Norrel 1994).

Test Reactor Area—The TRA DPWS is the result of water infiltrating form several different sources, including the CWP, CP, and sewage ponds. During the monitoring period from 1993 through 1996, chromium was detected in all monitoring wells with maximum concentrations ranging from 9 µg/L (PW-12) to 814 µg/L (USGS-53). Chromium concentrations in the DPWS for spring/summer 1995 ranged from nondetect in wells PW-12 and PW-13 to a maximum of 599 µg/L in well USGS-53. During the OU 2-12 monitoring period, chromium concentrations decreased slightly or were essentially unchanged in all wells except USGS-53, where a significant increase was observed (Arnett et al. 1996). During the monitoring period from January 1997 through January 1998 a single sample from USGS-55 exceeded the Idaho groundwater quality standard for chromium (>100 µg/L) (LMITCO 1998).

Radioactive Waste Management Complex—A monitoring well drilled into the deep perched water near the RWMC showed elevated concentrations of carbon tetrachloride (1.2 mg/L in 1987 and 1.4 mg/L in 1988), chloroform (0.65 mg/L in 1987 and 0.95 mg/L in 1988), 1,1,1-trichloroethane (0.14 mg/L in 1987 and 0.25 mg/L in 1988), trichloroethylene (0.86 mg/L in 1987 and 1.1 mg/L in 1988), tetrachloroethylene (0.11 mg/L in 1987 and 0.12 mg/L in 1988), 1,1-dichloroethylene (0.013 mg/L in 1987 and 0.022 mg/L in 1988) (Mann and Knobel 1987; Mann 1990). The concentration of these organic contaminants appears to have increased between 1987 and 1988. Elevated tritium concentrations have been detected in the shallow perched water near the RWMC (Humphrey and Tingey 1978, Bargelt et al. 1992).

Uranium was detected in some 1997 and 1998 sampling events in lysimeters in the SDA. Lysimeters near the soil vault rows show positive detects for tritium, carbon tetrachloride, and Technetium-99 for the 1997 and 1998 sampling. Plutonium 239/240 was detected in several lysimeters in 1997 and 1998, including lysimeters off the SDA completed in the 110 ft interbed.

Idaho Chemical Processing Plant—Elevated Sr-90 concentrations (9.8 pCi/L) have recently been observed in perched water near the INTEC. Although water from this well was also analyzed for Co-60 and cesium, neither compound was detected. The key contaminants of concern for

INTEC's perched water are plutonium and strontium-90. The concentration range for plutonium and strontium-90 are <0.02 to 0.19 pCi/L and 0.7 to 320,000 pCi/L, respectively. The only other fission product detected was Tc-99 with a maximum concentration of 105 ± 2 pCi/L in MW-5.

K-2.2.1.2 Surface Water. Because surface water does not flow directly off the INEEL site and there are no direct inputs to any of the intermittent surface water bodies by INEEL facilities, INEEL activities do not directly affect the quality of surface water bodies in areas outside of the INEEL (Hoff et al. 1990).

However, water from the Big Lost River does infiltrate into the SRPA and significantly influences chemistry on a local scale primarily by diluting constituents already present in the groundwater (Robertson et al. 1974; Wood and Low 1988; Bennett 1990). Diverting the Big Lost River affects the distribution of perched water, the resultant relative permeability, and ultimately the travel times of contaminants (LMITCO 1997b). Effects of the Big Lost River on water quality have been discussed in more detail in the above Vadose Zone section.

Selected physical and chemical water quality measurements made along the Big Lost River, the Little Lost River, and Birch Creek are provided in Table K-6. Although insufficient information is available to make statistical comparisons, the information collected from all sources to date indicates that overall water quality is similar in all three-water bodies. Water quality within all three-water bodies also appears to have varied relatively little over time (1963–1985). The chemical composition of each of these water bodies is controlled by the predominance of carbonate rocks (e.g., calcite and dolomite in the mountain ranges northwest of the INEEL, where they originate) and by agricultural uses including irrigation (Robertson et al. 1974, Bennett 1990). Chemical or physical parameters measured in these three water bodies do not exceeded water quality standards, and water quality in all three water bodies is adequate for all INEEL uses, including use as drinking water.

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Appendix L

Field Sampling Plan for the Decontamination and Dismantlement of the Security Training Facility

Appendix L

Field Sampling Plan for the Decontamination and Dismantlement of the Security Training Facility

The *Field Sampling Plan for the Decontamination and Dismantlement of the Security Training Facility* (INEEL/EXT-97-00664, R. W. Jones, Revision 1, issued March 1998) details the sampling requirements and activities associated with decontamination and dismantlement (D&D) of specified Operable Unit 10-04 sites. These sites include the sumps and pits in the basement of STF-601 and the STF gun range. The *Field Sampling Plan* was reviewed and approved independently from the OU 10-04 Work Plan by Waste Area Group 10 counterparts, i.e., U.S. Department of Energy, U.S. Environmental Protection Agency, and State of Idaho Department of Health and Welfare, so that agency comments could be obtained before D&D samples were taken in FY-98. All agency comments were resolved and/or incorporated and the revised *Field Sampling Plan* was released for use March 1998. A copy can be obtained from the Lockheed Martin Idaho Technologies Company Environmental Restoration Document Control and Records Management unit. Please ask for the latest revision.

Appendix M

Health and Safety Plan for the Sampling, Decontamination, and Dismantlement of the Security Training Facility

Appendix M

Health and Safety Plan for Sampling, Decontamination, and Dismantlement of the Security Training Facility

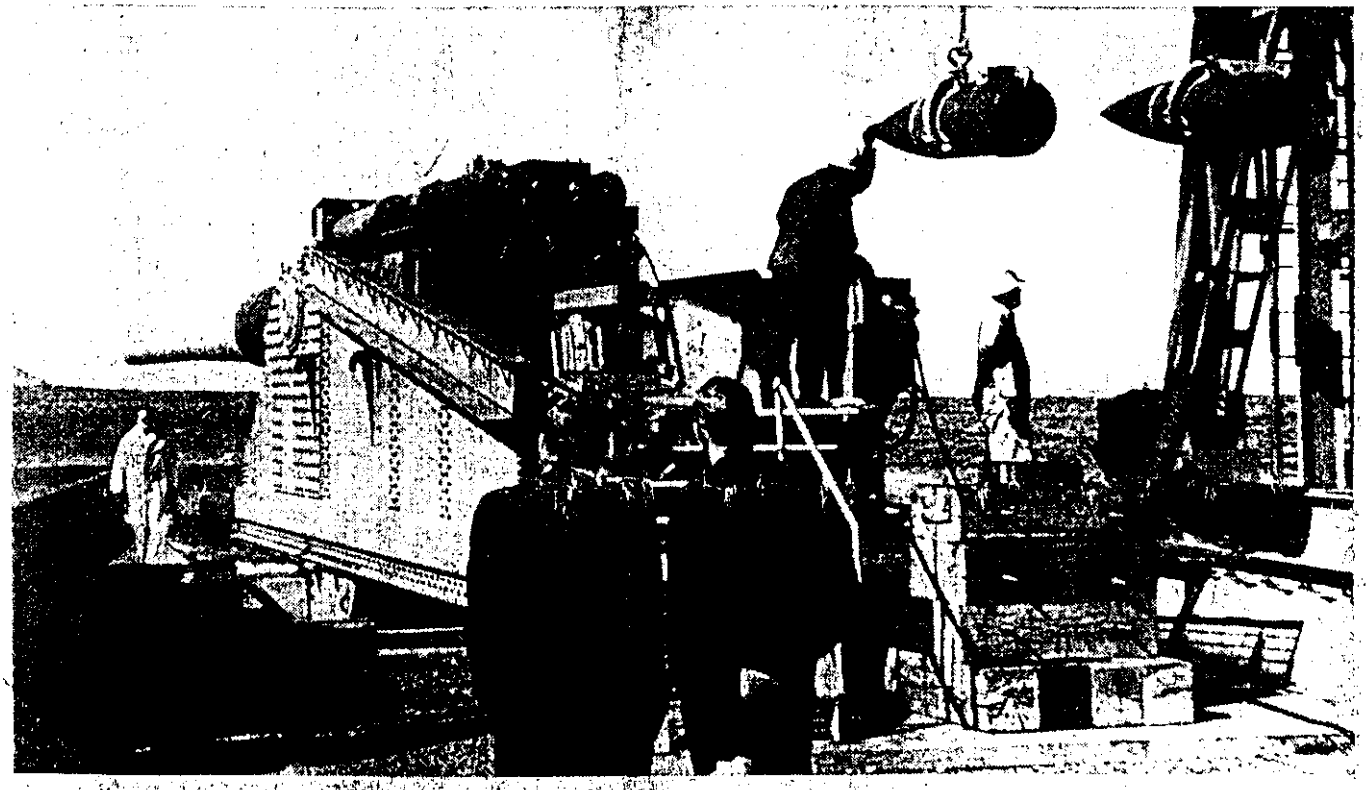
The *Health and Safety Plan for the Sampling, Decontamination, and Dismantlement of the Security Training Facility (STF)* (INEEL/EXT-98-00198, W. B. Carnes, March 1998) details the safety requirements for the sampling activities associated with Operable Unit 10-04 sites. These sites include the sumps and pits in the basement of STF-601 and the STF gun range. The *Health and Safety Plan* supports the *Field Sampling Plan for the Decontamination and Dismantlement of the Security Training Facility* (INEL/EXT-97-00664, by R. W. Jones, Rev. 1, March 1998). The *Health and Safety Plan* was reviewed and approved independent of the OU 10-04 Work Plan by the counterparts of Waste Area Group 10, i.e., U.S. Department of Energy, U.S. Environmental Protection Agency, and State of Idaho Department of Health and Welfare, so that agency comments could be obtained before D&D samples were taken in FY-98. All agency comments were resolved and/or incorporated and the *Health and Safety Plan* was released for use March 1998. A copy can be obtained from the Lockheed Martin Idaho Technologies Company Environmental Restoration Document Control and Records Management unit.

Appendix N

Newspaper Articles and Personal Interview Concerning Big Southern Butte

Post Register 12 - June - 1969

Big Naval Guns Boom On Th



The Lonely Idaho Desert

THE VAST Lost River Desert to the west of Idaho Falls resounded with explosions as 16-inch guns by the S and A Fabricating Co., of Pocatello, fired four shells into the base of the Southern Butte Wednesday. Upper left, shows the huge 2,700 pound projectile being lifted into the breech; upper right, the gun, destined to be placed aboard a battleship, firing. Lower left are three of the men in charge of the testing, from left, CWO John Simzisko, firing officer and U. S. Navy representative; Robert Van Der Beck, S and A project engineer, and Dave Bishop, S and A gun captain. Lower right is seen the impact of the dummy shell which digs a crater at the base of the Southern Butte some five miles away. The gun is capable of firing a distance of 30 miles. (Photos by Post-Register Photographer Mike Glass).

Naval Guns Test Firing At NRTS

A 16-inch naval gun on the Idaho Lost River Desert some 43 miles west of Idaho Falls fired a 2,700-pound projectile Wednesday and it landed amid a cloud of dust some five miles away at the base of the Southern Butte.

It wasn't a bonafide naval engagement, but just a test of a huge 16-inch naval gun, which is expected one day to b mounted on a bettleship.

The projectile carries no explosive or else a sizeable chunk of the butte would be carved out. At that it did stir up considerable dust, as can be imagined when more than a ton of steel is hurled some five miles.

Actually, the gun can fire such a shell some 30 miles away with accuracy.

Crew In Chicago

In charge of the crew were CWO 4 John Simzisko, firing officer and U.S. Navy representative; Robert Van Der Beck,

The barrels are loaded in a special flat car in Pocatello, then transferred to a trailer at the National Reacting Testing Station site for emplacement. The firing site is located some five miles southwest of the Central Facilities area.

Ironically, part of what is now the NRTS was formerly the Naval Proving Grounds where guns were fired on the test area.

Romantic Era, Windgill's Quotations In Times Three, Final Poems Selected For ople, Story of The eurature, and Underrt.

Offer Fruits

all kinds are on the h good prices and y this week.

and Arizona cantaespecially good now ger cantaloupes the and the prices rea-

grapefruit are now on the market from California and Arizona with good prices and good eating. Seedless grapes of much improved quality are also on the current market.

Although watermelon prices are currently quite high melons are good eating now with the California melons the best buy for eating quality.

Tropical fruits are now good on the market with exceptional

ss master's deblic administration na University. He years with the U. S. g the Korean War. rried to the former hhouse of Billings, have a son, Bob,

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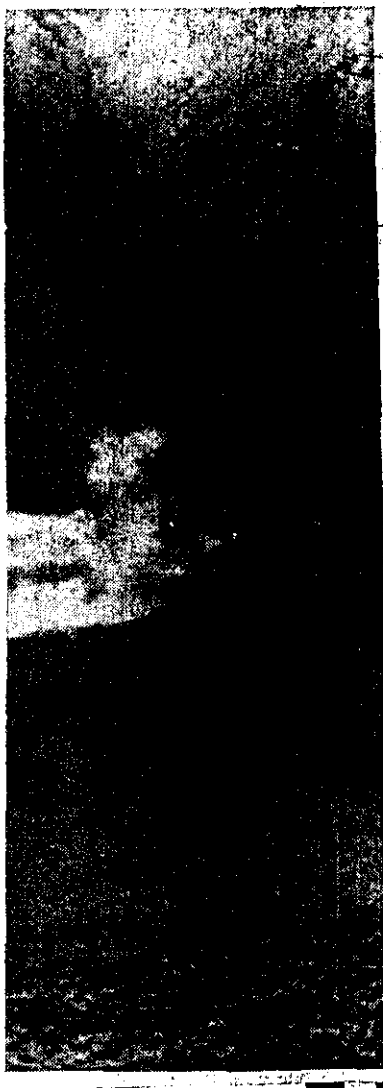

THE VAST Lost River Desert to the west of Idaho Falls resounded with explosions as 16-inch guns by the S and A Fabricating Co., of Pocatello, fired four shells into the base of the Southern Butte Wednesday. Upper left, shows the huge 2,700 pound projectile being lifted into the breech; upper right, the gun, destined to be placed aboard a battleship, firing. Lower left are three of the men in charge of the testing, from left, CWO John Simzisko, firing officer and U. S. Navy representative; Robert Van Der Beck, S and A project engineer, and Dave Bishop, S and A gun captain. Lower right is seen the impact of the dummy shell which digs a crater at the base of the Southern Butte some five miles away. The gun is capable of firing a distance of 30 miles. (Photos by Post-Register Photographer Mike Glass).

Naval Guns Test Firing At NRTS

A 16-inch naval gun on the Idaho Lost River Desert some 45 miles west of Idaho Falls fired a 2,700-pound projectile Wednesday and it landed amid a cloud of dust some five miles away at the base of the Southern Butte.

It wasn't a bonafide naval engagement, but just a test of a huge 16-inch naval gun, which is expected one day to be mounted on a bettleship.

The projectile carries no explosive or else a sizeable chunk of the butte would be carved out. At that it did stir up considerable dust, as can be imagined when more than a ton of steel is hurled some five miles.

Actually, the gun can fire such a shell some 30 miles away with accuracy.

Crew In Chicago

In charge of the crew were CWO 4 John Simzisko, firing officer and U.S. Navy representative; Robert Van Der Beck, project engineer for the S and A Fabricating Co., Pocatello, which is in charge of the testing; and Dave Bishop, S and A gun captain.

Four of the shells were fired late Wednesday morning, each about a half-hour apart.

Two guns were tested last week, and the remainder are scheduled for firing by June 19, said Van Der Beek.

Never Used

The guns testing were relined in 1945 but have never been

The barrels are loaded in a special flat car in Pocatello, then transferred to a trailer at the National Reacting Testing Station site for emplacement. The firing site is located some five miles southwest of the Central Facilities area.

Ironically, part of what is now the NRTS was formerly the Naval Proving Grounds where guns were fired on the test area.

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grapefruit are now on the market from California and Arizona with good prices and good eating. Seedless grapes of much improved quality are also on the current market.

Although watermelon prices are currently quite high melons are good eating now with the California melons the best buy for eating quality.

Tropical fruits are now good on the market with exceptional quality and prices. The New Zealand apples now on the market have been well accepted in the area, grocers report, pointing out that although they are

master's de-
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n University. He
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the Korean War.
ried to the former
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have a son, Bob,

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Post Register 12 June 1969

Desert Shakes as 16-Inch Navy Guns Test-Fired at Arco Station

By EMILY HONE

ARCO (AP) — With a roar guaranteed to strike terror into the heart of any unsuspecting antelope, coyote or jackrabbit lurking in the vicinity, a 16-inch Navy gun was fired at the National Reactor Testing Station near here.

The 120-ton gun barrels are from the battleship USS New Jersey and are being tested for combat safety after being relined, rebored and rerifled by S and A Fabricating, Inc., at Pocatello.

The gun barrels are shipped by rail to a spur at the NRTS, where they're towed to Central by Idaho Nuclear Corp. At Central they're loaded onto a 150-ton lowboy for the last stage of the trip to the firing range.

S and A engineer Robert VanDerBeek, who supervises the 16-man crew testing the guns, said four or five rounds have been fired at the test site every other day since February. Both eight and 16-inch gun barrels are tested. Due to the difficulty of positioning them because of size and weight, the guns are fired on alternate months.

In combat, the guns are capable of firing one round every three minutes and generate sufficient power to hurl an object the approximate weight of a compact car the distance of 23 miles, VanDerBeek said. The barrels must be relined after every 300 rounds.

A visitor to the firing range, expecting to return home with a giant shell casing as a souvenir, is always disappointed. There just isn't such an animal. The guns are loaded in a manner reminiscent of muzzle-loading rifles of frontier days, but from the reverse end.

In the case of the 16-inch guns, the projectiles weigh 2,700 pounds each and are loaded by crane onto a tray behind the barrel.

A mechanical rammer seats the shell, and a crew of men puts in from 500 to 700 pounds of gunpowder. One-half-inch long cartridges of solid copper inside a two and one-half inch steel housing are placed behind the powder charge and the breech block is then closed.

The copper cartridges are used to test the pressure put on the breech by the discharge of the gun, VanDerBeek said. A charge of powder 115 per cent in excess of that used in actual combat is used.

A naval officer is on hand to push the button which fires the gun, and final responsibility for what happens when the gun is fired rests with the Navy.

The loading crew signals "ready" to control, and VanDerBeek makes a final check by radio with men stationed at control towers on either side of the firing range. "If both men reply "firing range is clear," a siren signals everyone to shelter.

Visitors and crew stand inside two observation shacks made of one-inch steel. One shack houses firing controls. An eight-foot thick concrete wall protects the steel observation posts. That part of the wall extending beyond the steel shacks is topped by sandbags to protect the two trailer houses used for office space as well as other vehicles parked in the area.

Large padded ear protectors are donned by everyone and another siren sounds.

A burst of flame erupts from the muzzle of the gun and is coupled with a roar which must be the equivalent of a thousand old-time cannons. If the observer has a sharp eye he may catch a glimpse of the projectile as it is silhouetted against the sky between the gun and the distant butte which is its target.

A ball of dust blossoms on the side of the mountain and slowly descends toward the sagebrush, leaving behind a crater about 12 feet across and 20 feet long.

Even wearing protectors and expecting the blast beforehand doesn't compensate for the shock felt when the gun goes off. Half the windows in the trailer houses are missing due to the 900 pounds of concussion per square inch the blast generates.

When the all-clear siren sounds, the crew begins loading for another shot or returns to Central for another truckload of powder.

When the final round has been fired, the copper cartridges are checked and the amount of compression they have undergone indicates the pressure placed on the breech block.

If the breech isn't blown out by the 2,000,000 foot pounds of recoil, or the barrel isn't warped by the firing, the gun barrels are judged fit for combat use.

Accepted guns are loaded aboard railroad cars and returned to the New Jersey.

...om Seeks ...ourt Help ...or Student

...chool...men Refuse ...o Reinstate Girl ...acing Drug Count

...OCATELLO (AP) — A ...ther is petitioning Sixth Dis... Court in an attempt to ... her daughter reinstated in ...ol after school officials ex...ed the girl for alleged pos...sion of marijuana while at ...ol.

...on Black, 619 North Arthur, ...filed the petition for a writ ... behalf of her eli...

Receives Grant

UP Eyes Shutdown Over Strike

Saturday Action By Four Unions May Idle All Rails

POCATELLO (AP) — If four railroad shopcraft unions strike as scheduled Saturday, Union Pacific is prepared to shut down operations over its entire system. All other major railroads are expected to do the same, although the unions have announced strike plans against only six lines.

At Idaho Falls Meet

Mental Health Advice Panel Told Center Goes Forward

IDAHO FALLS (AP) — "Going forward very well," was program director Milton Madsen's report to the Idaho Mental Health Advisory Council for the first three weeks of the Eastern Idaho Community Mental Health Center's operation.

Madsen said that 58 patients are now being treated with six patients in the psychiatric ward of the Idaho Falls LDS Hospital.

In addition, he said, he is starting a partial care program for youth and adults and is starting in-service training activities for the 22 full and part-time staff members.

Judge Sleet said the present facilities often are "unsanitary, inadequate and have been the scene of suicides."

important in the development of a child's emotional and mental capacities."

The committee also favored the establishment of special education programs for emotionally disturbed children; that Idaho develop the Interdepartmental Committee on Children and Youth into an effective coordinating statewide organization; and favored the development of suitable regional detention homes for children.

Ms. Julie Sherwood:
LMITCO
P.O. Box 1625
Idaho Falls, Idaho 83415-3953

Dear Ms. Sherwood

Upon review of the "Memorandum of Conversation" we had on the 19th and the 21st of Jan 99, I felt that it would be beneficial to provide the following information in order to avoid further confusion. The accounts provided in newspaper articles are basically correct, depending who provided the information and during that time period.
The best I can ascertain after 30 years is that the project started about Oct 67 and lasted through Oct 69. This did not mean that the NOTF was active during this time period.
I was working for S & A Fabricating while I was going to ISU, and was placed in charge for the design and the construction of the NOTF. Upon completion of the site the company, with the approval of the Navy assigned me to manage the site and the gun crew.
The gun pit and the gantry foundation and supporting facilities were constructed during the winter months of 1967/1968. The gantry crane was assembled and placed in operation. The Contractor who was at the site at that time did the construction of the site. As I recall, it was Stearns & Rogers.
S & A completed the 16 " gun girder about March/April 67 and was transported to the site and placed over the pit. The first 16" gun was also being refurbished during this time period, which consisted of replacement, honing, and rifling of the liner, along with rebuilding and attaching the breach to the gun. The gun was then shipped to the NOTF, placed in the girder, and prepared for firing.
A Navy gunnery officer was assigned to the site, to assist in the training and safety procedures relating to the placement and preparing the gun for firing. This officer was also ultimately responsible to the Navy for the acceptance/rejection of each barrel tested and the overall success of the program. His name was John Simzisko.
The first 16" gun was checked out and was ready for firing as best I can recall about Jun/Jul 1968. This first barrel was a learning curve for all personnel involved, from the refurbishing operation through the test firing. Therefore the first firing was kept somewhat confidential; with the only agencies being notified being NRTS security and the BML.
This first test firing was successful having fired (5) five projectiles.
The 2nd –16'' gun was ready for firing about 4-6 weeks later, (4) projectiles were fired through this gun.
The 3rd through the 27th – 16 " gun, (3) projectiles were fired unless an additional projectile was required to verify the test results. This I recalled happened on only (2) occasions. One was reported in the Post Register article dated 12 Jun 1969.
The 8" barrels became available for testing; an 8" gun girder was fabricated and transported to the site. The 16" girder was removed from the pit and the 8" girder placed in position. The first 8" gun as I recall was fired about Sept/Oct 68. We were then firing twice a month, alternating between 16" and 8" guns.
Guns were becoming available more often as the refurbishing process became more efficient. We then started firing guns on a weekly basis, then on every other working day basis, as it took a day to switch girders.
When we completed the 16" program, we did not have to change out girders, and finished up the 8" program by firing every working day. A total of 33 – 8" guns were tested, firing (3) three projectiles through each barrel.

I am in hopes that the above sequence of events provides a better flow of events about the firing of the 16"- & 8" testing program, which was conducted at the NOTF.

Referring to the Memorandum of Conversation that we had, I will provide some further clarification.

Question # 1. The answer is correct. Yes, I was

Question # 2. I worked directly for S & A Fabricating, with the title of project engineer, until that time when I managed the firing program. When my title was project manager. During the management of the

site I was directly responsible to the Navy representative, with secondary responsibilities to S & A Fabricating.

Question # 3. The duration of the actual firing of the guns was approximately 1-½ years.

Note: I steered you wrong, you may be wasting your time with a security check of the time I was at the site. I was at the site previous to the NOTF program. I spent two summers out there studying to be a H.P.

None of the personnel required security clearance. However our activities were to be limited to Central and the NOTF.

Question # 4. See above discussion for clarification.

Question # 5. The only caliber guns fired were the 16" & 8" guns.

Question # 6. All projectiles fired both 16" and 8" projectiles were all dummy rounds. There were never any live rounds fired during the program.
I have attached a copy of the Post Register article dated 12 Jun 69. As you will note, it was reported in the third paragraph that "**The projectile carries no explosive"**

Question # 7. The number of 16" rounds fired from above discussion would be 90 projectiles.
The number of 8" rounds fired from above discussion would be 99 projectiles.

Question # 8. Both 16" and the 8" to my knowledge were never used to have a requirement to function as an armor-piercing projectile. Both guns did not have that kind of an accuracy, due to their use being for long range shelling. They were not coated with depleted uranium. Sorry if my statement misled you somewhat. I was involved in a base closure where smaller caliber projectiles had been coated with DU, and noticed pictures hanging on the walls of the 16" guns, and asked facility personnel if they ever coated that large of a projectile. Their answer was no, just smaller caliber projectiles.

Just a note of interest.

Mr. F. E Smith was head of security at the time of the program. I am sure by now he is retired, and may still live around Idaho Falls. He had a great interest in the program, and when ever photograph were taken, they would be turned over to him for development, reviewed by him and/or his staff for any security infraction and then turned over to us for Navy and/or our use. He would also requested if by change he could have a copy of the ones he was interested in. By the end of the program, his office at Central was covered with photographs. As I recall, at or about the completion of the program, we had a minimal amount of projectiles left in inventory. The value of the inventory for shipment back east exceeded the value of the projectiles. I therefore checked with Mr. Smith, to see if there was someplace where they could be disposed of on site. There wasn't. So they were to be shipped back to the plant in Pocatello for disposal. However, Mr. Smith had second thoughts and asked if by change we could leave (2) of the 16" projectiles at the site and/or if we could to place them in front of the Security building there at Central.

When I was at the site a few years ago working for MK, the projectiles were not sitting in front of the old security building. They had been moved. Knowing the paper work required to accomplish a task at the site, I am sure a work order exists which may show where the projectiles were moved to. If they were moved and stored on the site, they may be located and tested for du. The other suggestion I could give you, would be to contact Mr. Smith, if he is still around. He was one of our biggest fans. I am sure he could be of valuable assistance.

Under additional comments: Each barrel had records associated with them. From initial inspection through all phases of its serviceable life. More stringent than the records which are kept on a government vehicle. The only problem would be, to locate them. They would furnish proof that during the testing period, no live rounds were ever fired at the big butte. If you could locate the 16" projectiles which were left behind, you will notice that they are a solid piece of steel shaped liked the head of a high power rifle shell and standing

almost 6'-0" in height. You would also notice that there was no removable portion of the head of the projectile, which could be removed to load the projectile with explosives.

I hope that I have provided some information, which will benefit the work you are doing.

I state that the above statements are true to the best of my knowledge.

Robert Van der Beek 6 FEB 99

Robert Van der Beek Date:

If I can be of further help, please contact me.

Sincerely Yours

Robert Van der Beek

Memorandum of Conversation

Date: 1/19/99 and 1/21/99

Person Conducting Telephone Interview: Julie Sherwood, LMITCO

Person Interviewed: Robert Vanderbeek BEEK
3963 Bethle Road, BETHEL
Weatherford, Texas 76087
(817)-599-961

An October 3, 1969 Idaho Statesman newspaper article (page 7e columns 1-8) listed Robert Vanderbeek as the S and A Fabricating, Inc. engineer that supervised the 16-man crew testing the 120-ton gun barrels from the battleship USS New Jersey (see attachment). The gun barrels were fired from the Naval Ordnance Test Facility located at what was then named the National Reactor Testing Station and is now known as the Idaho National Engineering and Environmental Laboratory. The impact site was the Big Southern Butte approximately 4.5 miles away. The range of the guns in combat was listed in the article as 23 miles. The article describes the projectiles fired as weighing 2,700 pounds each loaded by crane onto a tray behind the barrel. A mechanical rammer seats the shell, and 500 to 700 pounds of gunpowder is added along with one-half-inch long cartridges of solid copper inside a two-and-one-half inch steel housing. The copper cartridges were used to test the pressure put on the breech by the discharge of the gun. The article states that four or five rounds were fired every other day since February. The article does not specifically disclose whether the shells were inert or live.

Questions asked Mr. Vanderbeek

1. **Are you the Robert Vanderbeek that supervised the test firing of the New Jersey gun barrels in 1969 at the National Reactor Testing Station now known as the INEEL?**
—Yes.

2. **Who did you work for and what was your position/job title?**
—I worked for a company called S and A Fabricating. I was going to college at the time. S and A Fabricating leased a building in Pocatello where they manufactured the guns/gun barrels. ~~We~~ THE COMPANY pursued and secured a contract with the navy to refurbish the gun barrels. I graduated and was in charge of designing and establishing the site that we fired the guns, the NOTF (Naval Ordnance Test Facility). The crane that loaded the gun barrels at the NOTF was moved and is now located at Central Facilities. I worked for S and A for five years and my position was equivalent to Project Manager.

USED TO
WERE
SHOT TEST

3. **What was the duration that you tested the gun barrels and fired at the Butte?**
—Approximately one-and-a-half- years. ~~(Note: The actual duration can be checked by doing a security check on Mr. Vanderbeek's security clearance.)~~ I TOLD YOU IN ROW - WE DID NOT REQUIRE CLEARANCE - I WAS AT SITE PRIOR TO THAT TRAINING AS H.P.

4. **The article states that you fired every other month alternating between 8-inch and 16-inch guns. Is this true?** - SOMEWHAT - SEE ATTACHED WRITE UP.
—That was probably accurate at the time but we got pretty good at refurbishing the guns and we alternated every other week. Clarification added 1/21/99--The article states that the guns were fired every other day (since February) and that due to the difficulty in positioning them because of the size and weight, the guns are fired on alternate months. So to clarify your earlier statement, you started by firing every other month, then progressed to every other week, then toward the end you were firing every other day? But the guns were alternated monthly?

—Yes, but when we first started, all we had were the 16-inch barrels. So we did not alternate. We started out slower and then got better. The Navy saw how successful we were with the 16-inch and they gave us the contract for the 8-inch barrels too. The contract for the 8-inch came later in the year. So we only had the 16-inch at first. Toward the end of the contract we were firing every other day but we didn't always fire every other day because we had to take the 16-inch gun girder and replace it with the 8-inch and that took a day after we got good at it. Replacing the girder took more time in the beginning.

5. **Were any caliber guns other than the 16-inch and 8-inch ever fired from the NOTF?**
—No

6. **Were live rounds ever fired from the NOTF?**
—No, just the dummy shells, three dummy shells per barrel. No live rounds were fired at any time.

SEE ATTACHED W RATE UP.

7. **How many rounds were fired from the NOTF?**
—Each barrel had three dummy shells fired. Each barrel was fired a total of three times to test. The test used increasing amounts of gunpowder beginning with about 600 pounds of gunpowder working up to about 790 pounds of gunpowder in the last charge. A total of 27 16-inch Naval barrels were refurbished. They came in 13 pieces that fit into one gun barrel. It took one week to heat the barrels then they were cooled with water. Each barrel took one month to take apart and refurbish. It was an ongoing operation. When the gun was done it was transported out to NOTF and fired three times. Once it tested satisfactorily, it was returned to Pocatello and sent back east. We waited for at least three barrels to be complete prior to shipping. Approximately 30-40, maybe 35 total, 8-inch gun barrels were tested. Each were fired three times. All dummy shells. After we fired the tests, we drove out to the butte to check our accuracy. We tried to shoot one shell on top of another. We got pretty good. I was there from day one to the last day the last barrel was shot and no live rounds were ever fired. **(27 x 3 = 81) (40 x 3 = 120) (81 + 120 = 201 total)**

8. **(1/21/99) Were depleted uranium projectiles ever fired from the NOTF?**
—No. This subject came up earlier when I worked at another army base. I worked at a base closure in Chicago where they actually coated the shells with du (depleted uranium). The shells at the NOTF were clean, they were not coated with du (depleted uranium). Neither the 8-inch nor the 16-inch.

Additional comments:
a) Ron Vanderbeek (works at TRA at the INEEL) is Robert's brother.
b) Each gun barrel had a chain of custody. Records were filled out and recorded. Records exist somewhere.

I state that the above statements are true to the best of my knowledge

Rob Vanderbeek — 6 FEB 99

Robert Vanderbeek — Date

Appendix O

Ordnance Treatability Study Documents

Please refer to the most recent version of these controlled documents.

Health and Safety Plan for the Ex-Situ Biological Remediation Treatability Study on Soils Contaminated with Explosive Materials—INEEL/EXT-98-00847

Work Plan for the Ex Situ Biological Remediation Treatability Study on Explosives-contaminated Soils—INEEL/EXT-98-00775

Field Sampling Plan for OU 10-04 RDX/TNT CERCLA Treatability Study of Biological Remediated Soils Contaminated with Explosive Materials at the Idaho National Engineering and Environmental Laboratory—INEEL-EXT-98-00576